

# *Modbus Communicating I/O Modules*

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for General Applications

Installation & Operation Manual  
Version 1.01

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*“The Leader in Web Accessed Power Monitoring”*



**Nexus I/O Modules  
for Nexus High Performance  
Monitors  
Version 1.01**

Published by:  
Electro Industries/GaugeTech  
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## About Electro Industries/GaugeTech

Electro Industries/GaugeTech was founded in 1973 by Dr. Samuel Kagan. Dr. Kagan's first innovation, an affordable, easy-to-use AC power meter, revolutionized the power-monitoring field. In the 1980s Dr. Kagan and his team at EIG developed a digital multifunction monitor capable of measuring every aspect of power. EIG further transformed AC power metering and power distribution with the Futura+ device, which supplies all the functionality of a fault recorder, an event recorder and a data logger in one single meter. Today, with the Nexus 1252 and 1272, EIG is a leader in the development and production of power-monitoring products. All EIG products are designed, manufactured, tested and calibrated at our facility in Westbury, New York.

## Products

EIG product applications include:

- Multifunction power monitoring
- Single and multifunction power monitoring
- Power-quality monitoring
- Onboard data logging for trending power usage and quality
- Disturbance analysis

### Futura+ Series

- Power-quality monitoring
- High-accuracy AC metering
- Onboard data logging
- Onboard fault and voltage recording

### DM Series

- Three-phase multifunction monitoring
- Wattage, VAR and amperage
- Modbus, Modbus Plus, DNP 3.0 and Ethernet protocols
- Analog retransmit signals (0–1 and 4–20mA)

### Single-Function Meters

- AC voltage and amperage
- DC voltage and amperage
- AC wattage
- Single-phase monitoring with maximum and minimum demands
- Transducer readouts

### Portable Analyzers

- Power-quality analysis
- Energy analysis



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# Chapter 1 Introduction

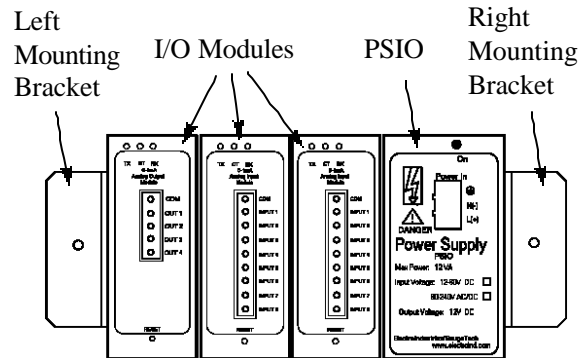
## 1.1: Introduction

- Electro Industries' Modbus I/O modules perform as compact, affordable communication interfaces between the real world and the technical world of devices. These modules can support more metering functions for Electro Industries' meters or, with proper power supply, these modules can also be used independently. As an add-on or a stand-alone, each of these Analog or Digital Modbus I/O Modules can interface, condition and/or distribute critical signals for a variety of applications. Five types of modules are available. They are rugged, high-performance, highly expandable and user friendly. Below is a **Quick Start Guide** for using the modules. Steps are detailed in later chapters.

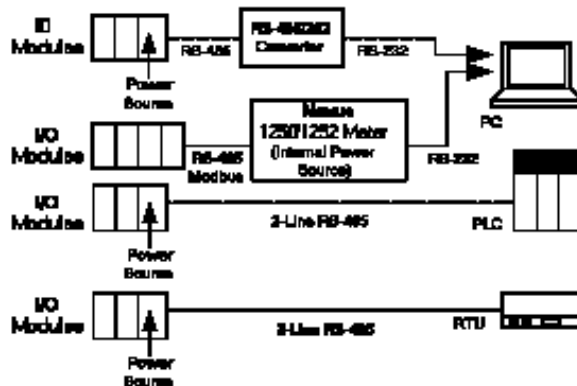
## 1.2: Quick Start Configuration Guide (See Chapter 2 for Expanded Installation)

1. **Install Communication Software :** Nexus Communicator or Nexus Programmer (Shareware). Nexus Programmer can be downloaded from [www.electroind.com](http://www.electroind.com).
2. **Assign a Unique Address to Module** (for more than one of the same Module) (Section 2.2.2).
3. **Determine Power Needed.** Nexus 1250/1252 and PSIO provide 12 VA. Rule of thumb:  
1 Power Source for up to 4 I/Os. See Steps to Determine Power Requirement (Section 2.2.3).

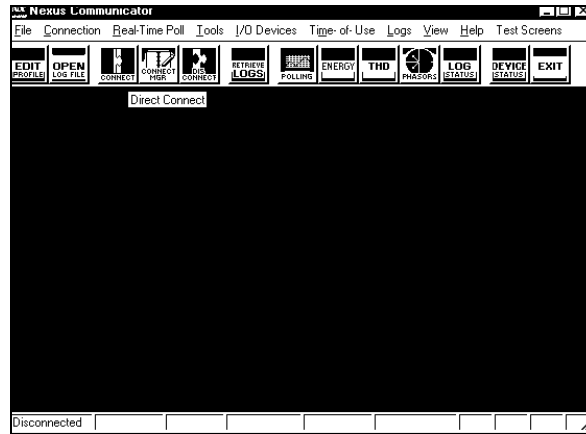
4. **Mount and Power the I/O Modules**  
Use a Mounting Bracket (MBO) and **Power Supply**, if needed. Starting with the Left Module, fasten Left Mounting Bracket. Use the Integrated Fastening System to add additional I/Os (up to 31) to the right (**loosely**) with an external Power Source (PSIO) to the RIGHT of each grouping of 4. With all I/Os in place, fasten **tightly**. Then, attach Right Mounting Bracket.



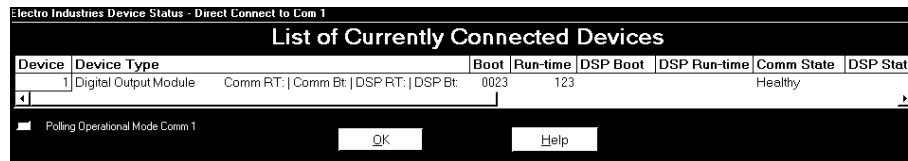
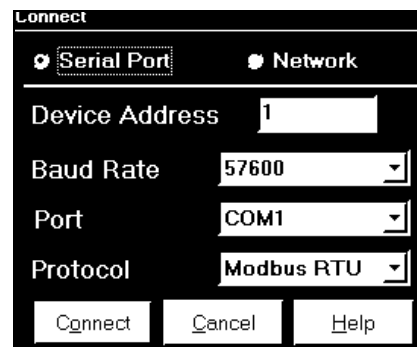
5. **Install RS-485 Communication Wiring**  
I/O Module can communicate via RS-485 to Nexus meters, via RS-485 to an RS-485/RS-232 Converter to a PC or via 2-wire RS-485 to a PLC or RTU. Refer to section 2.2 for wiring details.
6. **Communicate to I/O Modules with Nexus Communicator or Nexus Programmer (Shareware)**  
Nexus Programmer has similar screens and most capabilities except Log Viewer.



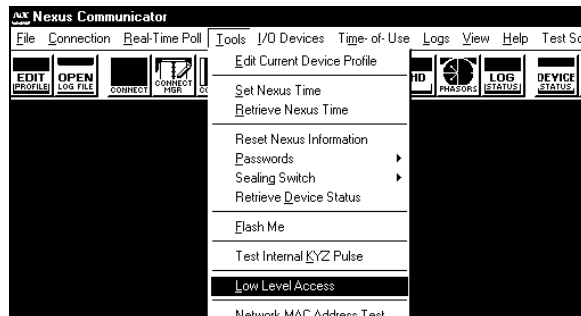
- Click on **Nexus Communicator** or **Nexus Programmer Icon** (in a file on your PC).  
The Main screen appears.  
The Programmer screen will differ slightly with a few less icons.



- Click **Connect**.  
The Connect screen appears.
- Type **Address** and use **pull-down menus** to **Input Settings** as shown. **Protocol MUST be Modbus RTU**.
- Click **Connect**.  
The Device Status screen shows **Boot**, **Run Time** and **Comm Status** for connected device(s).  
**Click OK**.  
The Main screen reappears.



- On the Main screen, click **Tools > Low Level Access**.



- On the **Low Level Access** screen, check **Convert to Hex** and from the **pull-down menu**, select **CRC 16EI/MB RTU**.  
Now **Low Level Access** is ready to send and receive **Commands** to and from the **I/O Module(s)** connected to the PC.



- Type a Command into the Command window.  
Click SEND.  
A Response will appear in the lower window.

**RESET:** Pushing the RESET button for 3 seconds will cause the unit to run in Default Mode (Address 247, Baud Rate 57600).

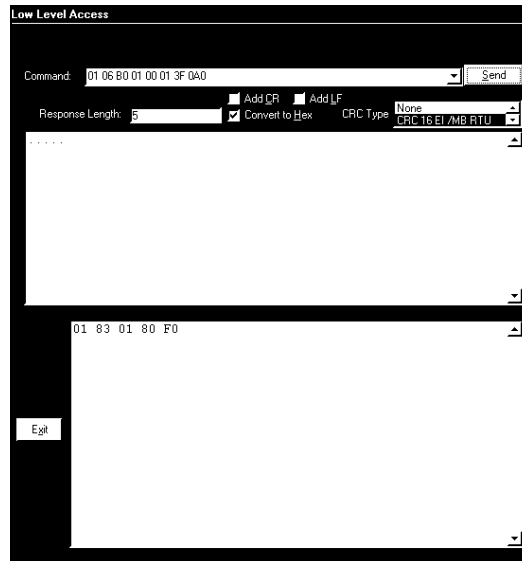
### 1.3: Example Commands

Change the Unit Address from Default to 1.  
**F706B000001** (No Spaces)

RESET Command (the Unit Address will be 1)  
**F706FF810001** (No Spaces)

Change Baud Rate on unit with Unit Address of 1, Baud Rate 57600 to Baud Rate 9600  
**0106B0010001** (No Spaces)

Change Unit Address to 1, Baud Rate to 9600 and Transmit Delay Time to 0.  
(Current settings: Address 247, Baud Rate, 57600, Transmit Delay 20 csec)  
**F710B000000306000100010000** (No Spaces)

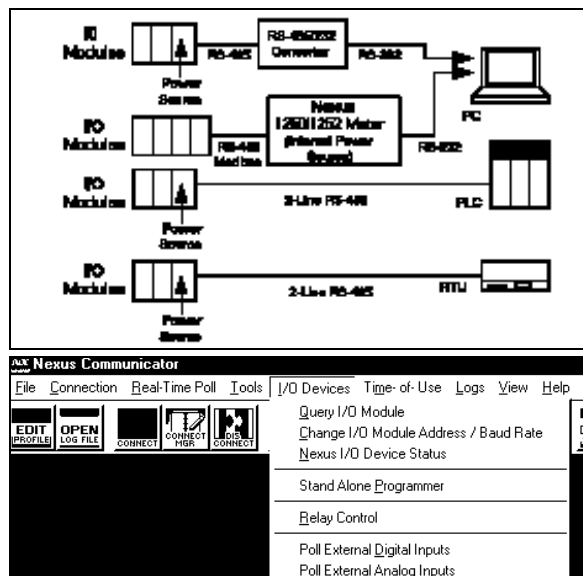


### 1.4: Change the Device Address with Stand Alone Programmer

This function is used when two or more of the same I/O Module are to be mounted together. Each I/O Module MUST have its own **UNIQUE ADDRESS**. With this screen the user can easily create a Unique Address **BEFORE** the units are mounted together. If the I/O Modules are not programmed separately, they will answer to the same Address.

#### Steps to Use the Stand Alone Programmer

- Connect one I/O Module (and a Power Source) to a PC (on which Nexus Communicator or Nexus Programmer is installed).
- From the Nexus Communicator or Programmer Toolbar, click I/O Devices > Stand Alone Programmer. The Stand Alone Programmer screen appears.



**3. Type New Address in Address window.**

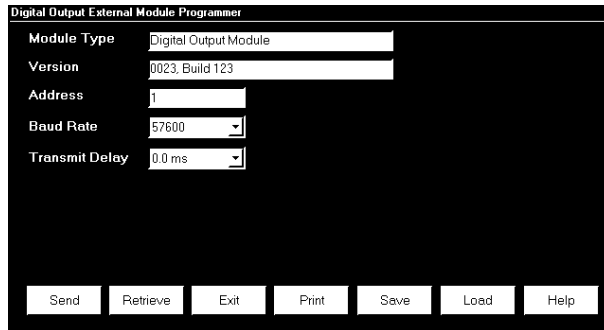
Baud Rate and Transmit Delay can also be changed.

**4. Click Send Button.**

The Send button automatically Restarts the I/O Module being changed.

**5. Click EXIT** to close the screen and

return to the Main Nexus Communicator or Nexus Programmer screen.



## 1.5: Electro Industries' Modbus I/O Modules and Accessories

### 1. Analog Transducer Signal Output Modules

- a. 1mAON4 - 4 Analog Outputs, 0-1 mA, scalable, bidirectional
- b. 1mAON8 - 8 Analog Outputs, 0-1 mA, scalable, bidirectional
- c. 20mAON4 - 4 Analog Outputs, 4-20 mA, scalable
- d. 20mAON8 - 8 Analog Outputs, 4-20 mA, scalable

### 2. Analog Input Modules

- a. 8AI1 - 8 Analog Inputs, 0-1 mA, bidirectional
- b. 8AI2 - 8 Analog Inputs, 0-20 mA, bidirectional
- c. 8AI3 - 8 Analog Inputs, 0-5V DC, bidirectional
- d. 8AI4 - 8 Analog Inputs, 0-10V DC, bidirectional

### 3. Digital Dry Contact Relay Output Modules

- a. 4RO1 - 4 Relay Outputs, 5 amps, 125 AC/DC, Form C

### 4. Digital Solid State Pulse Output (KYZ) Modules

- a. 4PO1 - 4 Solid State Pulse Outputs, Form A or C KYZ Pulse

### 5. Digital Status Input Modules

- a. 8DI1 - 8 Digital Status Inputs, Wet/Dry, Auto-Detect up to 300 Volts AC/DC

- The Electro Industries I/O Modules have accessories that are available to aid in installation and in powering the modules:

**PSIO:** Power Supply for up to 4 I/O Modules.

**PB1:** Power Supply provides 24-48V AC.

**MBIO:** Mounting bracket for I/O Modules.

# Chapter 2 Installation

## 2.1: Hardware Overview

- All Electro Industries External I/O modules have the following components:
  - **Male RS-485 Side Port:** use to connect to another module's female RS-485 side port.
  - **Female RS-485 Side Port:** use to connect to a port of a Master Device with power supply or to another module's male RS-485 side port.
  - **I/O Port:** used for functions specific to the type of module; **size and pin configuration vary depending on type of module.**
  - **Reset Button:** Press and hold for three seconds to reset the module's **Baud Rate to 57600** and its **Address to 247 (0x0F7)** for 30 seconds.
  - **LEDs:** when flashing, signal that the module is functioning.
  - **Mounting Brackets (MBIO):** used to secure one or more modules to a flat surface.

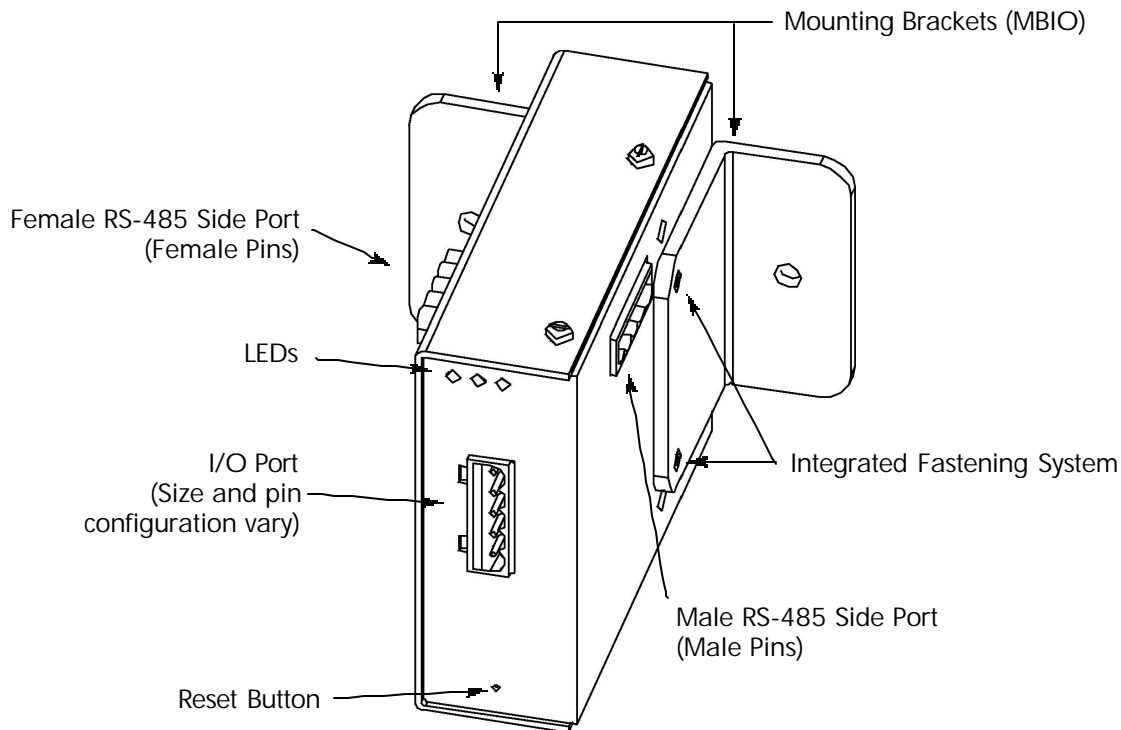
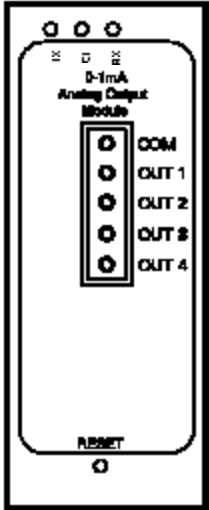


Figure 2.1: I/O Module Components

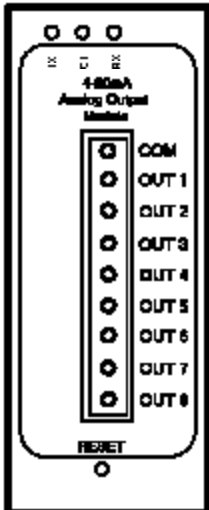
**2.1.1: Port Overview**

- All Electro Industries I/O Modules have ports through which they interface with other devices. The port configurations are variations of the four types shown below.

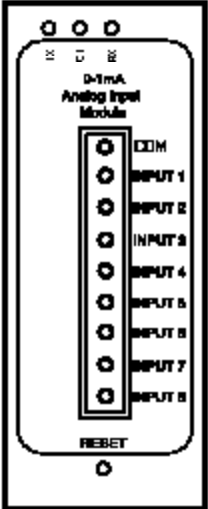
**Four Analog Outputs  
(0-1mA and 4-20mA)**



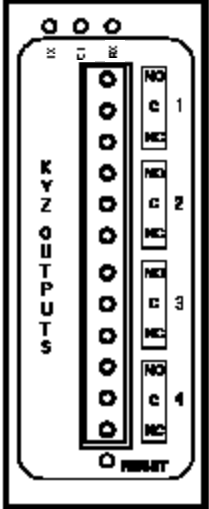
**Eight Analog Outputs  
(0-1mA and 4-20mA)**



**Eight Analog Inputs  
(0-1mA, 0-20mA,  
0-5V DC, 0-10V DC)  
or Eight Status Inputs**



**Four Relay Outputs  
or Four KYZ Pulse Outputs**





## 2.2: Install External I/O Modules

- A Quick Start Configuration Guide can be found in section 1.2. Section 1.2 is an overview of the Installation process. The Installation process is very simple. However, the modules can be used to interface with a variety of devices. So, we offer here an expanded detailing of the Installation process with a variety of scenarios for your information.

### 2.2.1: Install Communication Software

- Nexus Communicator or Nexus Programmer (Shareware) can be used to communicate with the I/O Modules.

Nexus Programmer can be downloaded at no cost from the Electro Industries website, [www.electroind.com](http://www.electroind.com). Nexus Programmer provides communication between the I/O Modules and a PC and/or a Nexus meter.

Nexus Communicator can be purchased from Electro Industries by visiting our website, [www.electroind.com](http://www.electroind.com), or calling our National Headquarters at 800-645-6342. Nexus Communicator provides all the communication of Nexus Programmer plus additional memory features, such as logging. In either case, simply follow the instructions on the installation screens until the software is successfully installed.

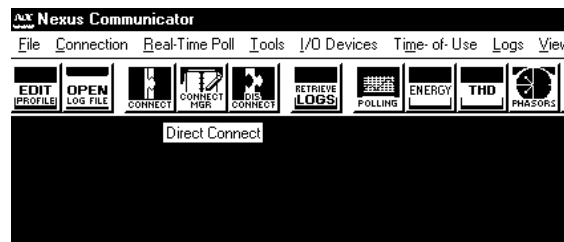
### 2.2.2: Assign a Unique Address and Change Settings

- This step is **NOT REQUIRED** unless the user wants to install **more than one of the same type of module in a group** or the user wishes to change the Device Address or other settings. Each module is programmed with a factory-set address shown in Table 2.1. The Device Address as well as Baud Rate and Transmit Delay can be changed using the steps here.

When programming the modules, **the modules must be separate** (but attached to a power source); otherwise, they will answer to the same address. Simply program the module **BEFORE** mounting in a group or unfasten, program, then refasten the modules.

To program a module, follow these steps:

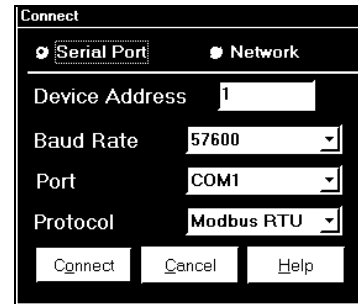
1. **Connect** a single I/O Module, power source and RS-485/RS-232 Converter to a PC or a single Module to Nexus 1250/1252 (power source & converter) to a PC.
2. **Click on the Nexus Communicator (or Programmer) Icon** (located in a file on your PC) to open the software program. The Main screen for Nexus software will appear.
3. **Click the Connect Icon.**  
The Connect screen appears.



**3. Type the current Device Address.**

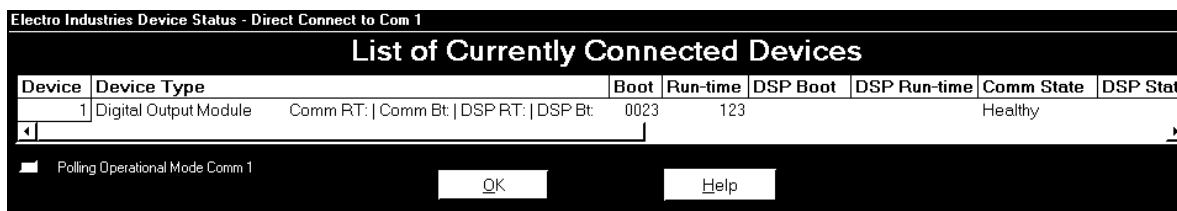
Use the pull-down menus to Input Settings as shown.  
Baud Rate and Port settings can change.  
**The Protocol MUST be Modbus RTU.**

**NOTE: If you do not know the Address and Baud Rate, push the I/O Module RESET button for 3 seconds.**  
RESET will cause the unit to run in Default Mode (Address 247, Baud Rate 57600). Use those settings to connect to the module.



**4. Click the Connect button at the bottom of the screen to connect the module to the PC.**

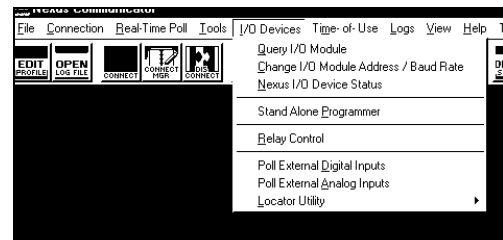
The Device Status - Direct Connect to Com 1 screen appears showing the Boot, Run Time and Comm Status for the connected device(s). (The screen creates a list if more than one device is connected.)



**5. Click OK.** The main screen will reappear.

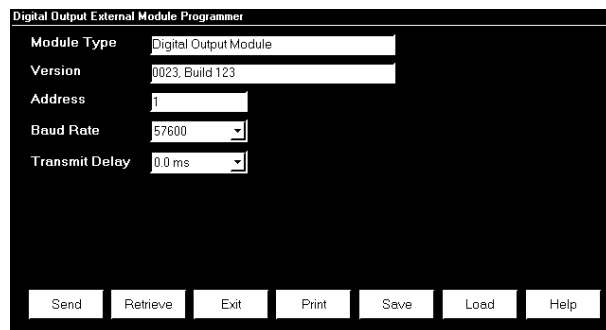
**6. Click on I/O Devices > Stand Alone Programmer** (from the Tool Bar).

The Stand Alone Programmer screen for the connected I/O Module appears (the screens vary slightly).  
The Module Type and Version windows confirm the module to which you are connected.



**7. Click on the windows to change the Address, Baud Rate and/or Transmit Delay.**

The user can Send/Receive settings to and from the I/O Module with the **Send** or **Retrieve** button.



The user can Save/Load settings to or from files on the PC Disc Drive with the **Save** or **Load** button.

**8. Click the Send Button** to automatically Restart the I/O Module which will save changes.

**9. Click Exit** to Close the Stand Alone Programmer screen and return to the Nexus Communicator or Programmer screen.

### 2.2.3: Steps to Determine Power Requirement

- A Nexus 1250/1252 is able to power up to four modules (**two** Analog Output Modules) using 15–20V DC at 50–200mA. Other devices may have little or no power.
  - Refer to Table 2.1 below to determine the VA Ratings for each I/O Module. (NOTE: If external displays are in use, they must be considered.)
  - Determine Power Requirement by adding together the VA Ratings for **I/Os Modules** in use.
  - Compare Available Power to Power Required.
  - Use additional Power Supply (PSIO) if more power is required.

**NOTE:** The Nexus 1250/1252 or PSIO provide only 12VA of power.

**NOTE:** RS-485 communication is viable for up to 4000 feet (1212 meters). However, if your cable length exceeds 200 feet, use an additional power supply **and use termination resistors at each end ONLY IF NEEDED.**

#### 2.2.3.1: Factory Settings and Reset Button

- All I/Os are shipped pre-programmed with a Baud Rate of 57600 and Addresses. The table below details the factory-set Address and the VA Rating for each I/O Module.
- If there is a communication problem or if you are unsure of a module’s Address and Baud Rate, press and hold the RESET button for 3 seconds; the module will reset to a Default Address of **247 at 57600 baud for 30-seconds**. This will enable you to interrogate the I/O Module in Modbus RTU protocol. The module’s Address and Baud Rate can be read from Registers 45057-45058 (0x0B000-0x0B001) in the Modbus Map for each I/O Module.

SETTINGS & VA RATINGS FOR I/O MODULES AND DISPLAYS			
Model Number	Module	Address	VA Rating
1mAON4	0-1mA, 4 Analog Outputs	128	2.7 VA
1mAON8	0-1mA, 8 Analog Outputs	128	3.2 VA
20mAON4	4-20mA, 4 Analog Outputs	132	5.0 VA
20mAON8	4-20mA, 8 Analog Outputs	132	8.5 VA
8A11	0-1mA, 8 Analog Inputs	136	2.3 VA
8A12	0-20mA, 8 Analog Inputs	140	2.3 VA
8A13	0-5V DC, 8 Analog Inputs	144	2.3 VA
8A14	0-10V DC, 8 Analog Inputs	148	2.3 VA
4ROI	4 Latching Relay Outputs	156	2.7 VA
4POI	4 KYZ Pulse Outputs	160	2.7 VA
8D11	8 Status Inputs (Wet/Dry)	164	1.0 VA

Table 2.1: Settings & VA Ratings for I/O Modules

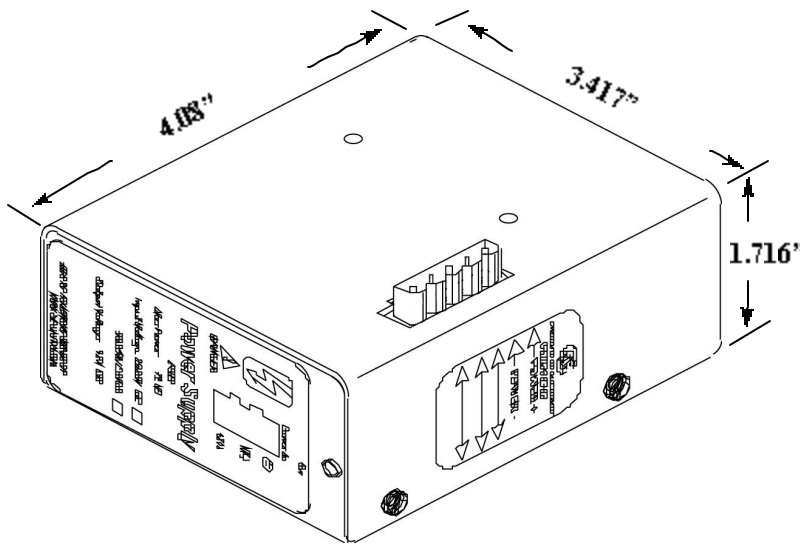
**NOTE:** See section 2.2.2 to **Change Settings** (if needed).

## 2.2.4: Additional Power Source for I/O Modules

■ The EIG PSIO (12 VA) is an additional power source for I/O Modules. Dimensions of the PSIO are: Height: 3.41", Width: 1.71", Depth: 4.08". Below are the labels for the PSIO.

■ Power Connection:

1. Connect the PWR(+) of the PSIO to the male PWR(+) of the I/O Module; connect the PWR (-) of the PSIO to the male PWR (-) of the I/O Module.
2. For additional I/O Modules, connect the male RS-485 connector of the additional module to the female RS-485 connector of the existing module.
3. Connect the shield to the shield (S) terminal. The (S) terminal is not an earth ground connection. You must also connect the shield to earth-ground at one point.



SIDE LABEL

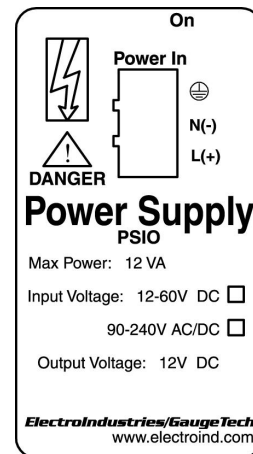


Figure 2.3: The PSIO Power Source (Male RS-485 Side Port)

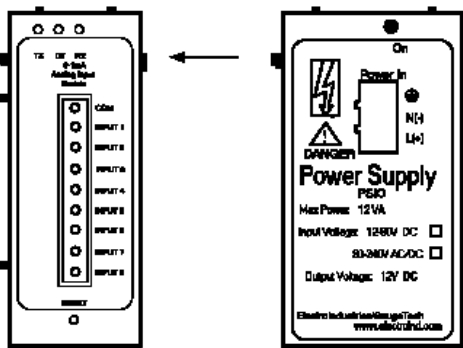


Figure 2.4: Power flow from PSIO to I/O Module

TOP LABEL

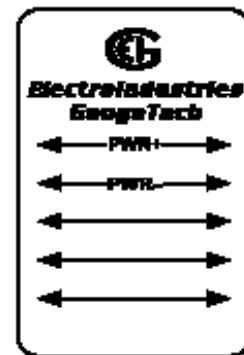
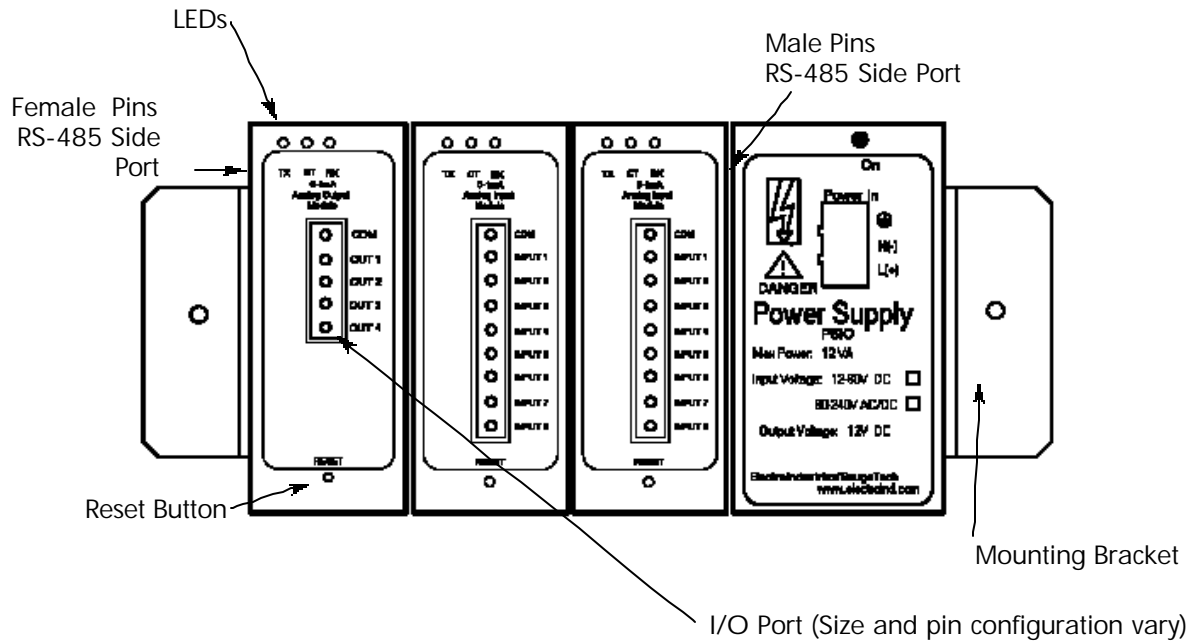


Figure 2.5: Labels for the PSIO Power Source (Labels are Red & White)

## 2.2.5: Mount and Power Multiple I/O Modules



I/Os must use a compatible port. See the Master Device’s user’s guide to determine the proper port. Set the port to 57600 Baud, Master. If the Master Device does not have sufficient power to support the I/O Modules in use, add a Power Supply.

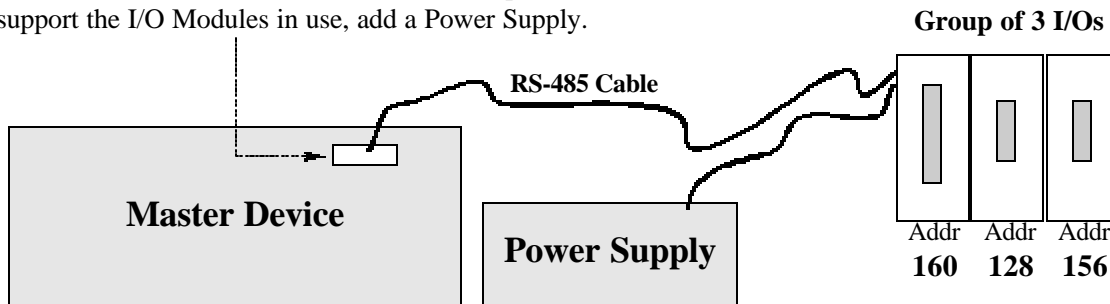


Figure 2.6: Multiple I/Os

### ■ Steps for Attaching Multiple I/O Modules

1. Each I/O module in a group **must be assigned a Unique Address**. See section 2.2.2.
2. Determine if you must use an **additional power source**, such as the EIG PSIO (section 2.2.3).
3. **Starting with the left module** and using a slotted screw driver, fasten the first I/O Module to the **left Mounting Bracket**. The left Mounting Bracket is the one with the **PEM**. Fasten the internal screw **tightly** into the left Mounting Bracket.

- Next, slide the female RS-485 port into the male RS-485 side port to connect the next I/O module to the left module. **Fasten together enough to grab but do not tighten.** One by one combine the modules together using the **Integrated Fastening System (Figure 2.7)**. If you require an additional power supply, attach a **PSIO** (power supply) to the right of each group of **4 I/O Modules** (section 2.2.3).

NOTE: The **PB1** can also be used for a Low Voltage Power Supply. It must be mounted separately.

- Once you have combined all the I/O modules together for the group, **fasten tightly**. **This final tightening will lock the whole group together as a unit.**
- Attach the **right** Mounting Bracket to the right side of the group using small phillips head screws provided.
- Then, mount the group of modules on a secure, flat surface. This procedure will ensure that all modules stay securely connected.

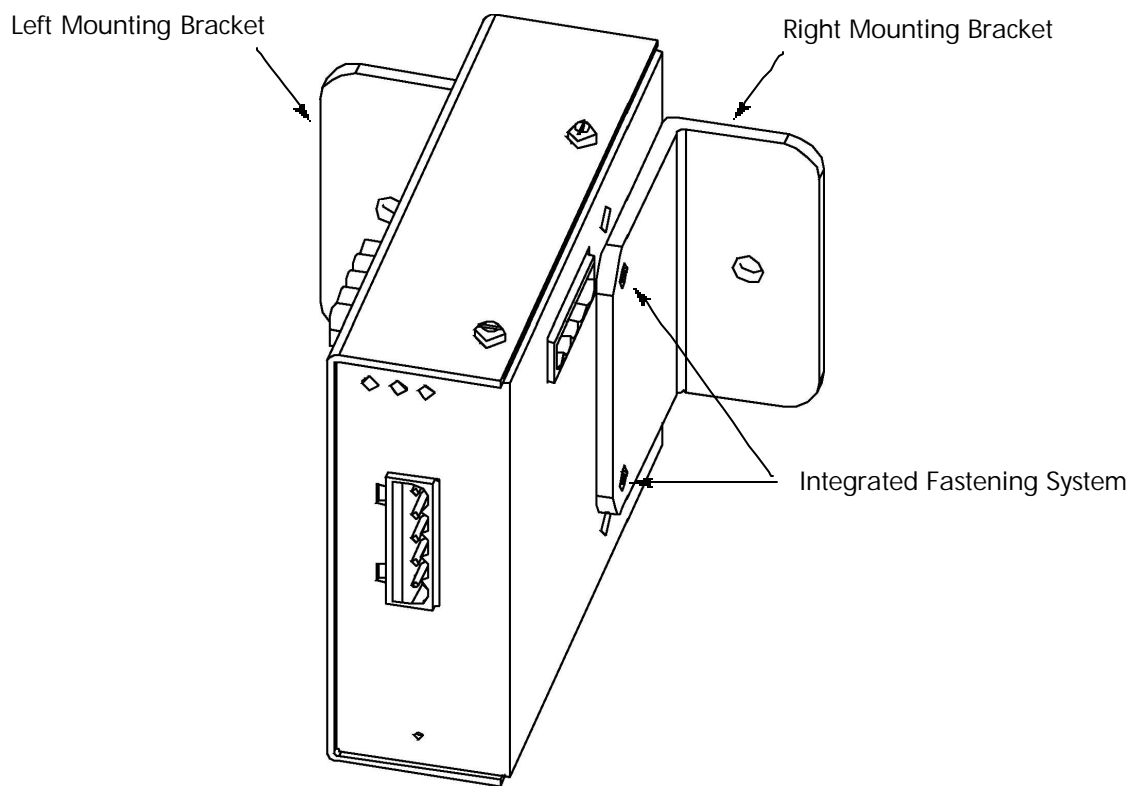


Figure 2.7: Integrated Fastening System

## 2.2.6: Wire RS-485 Communication to the I/O Modules

- When wiring an individual I/O Module or a group of modules for RS-485 communication, keep the following in mind:

Nexus 1250/1252 has an internal power source and is able to power up to four modules (**two** Analog Output Modules) using 15–20V DC at 50–200mA, represented by dashed lines in Figure 2.8 below. For more than 4 I/O Modules or to connect to another device, refer to section 2.2.3 and use an External Power Source as shown below.

RS-485 communication is viable for up to 4000 feet (1212 meters). **However, if your cable length exceeds 200 feet, use the additional power supply and use termination resistors at each end ONLY IF NEEDED**, connected to the A(+) and B(-) lines.  $R_T$  is approximately 120 Ohms.

Connect the A(+) and B(-) terminals of the male RS-485 connector of the I/O Module to the A(+) and B(-) terminals of the Master Device. Connect the shield(S) terminal to the shield of the Master Device. The shield (S) terminal is not an earth ground connection. You must also connect the shield to earth-ground at one point.

**NOTE: Use 20 AWG shielded cable for connections.**

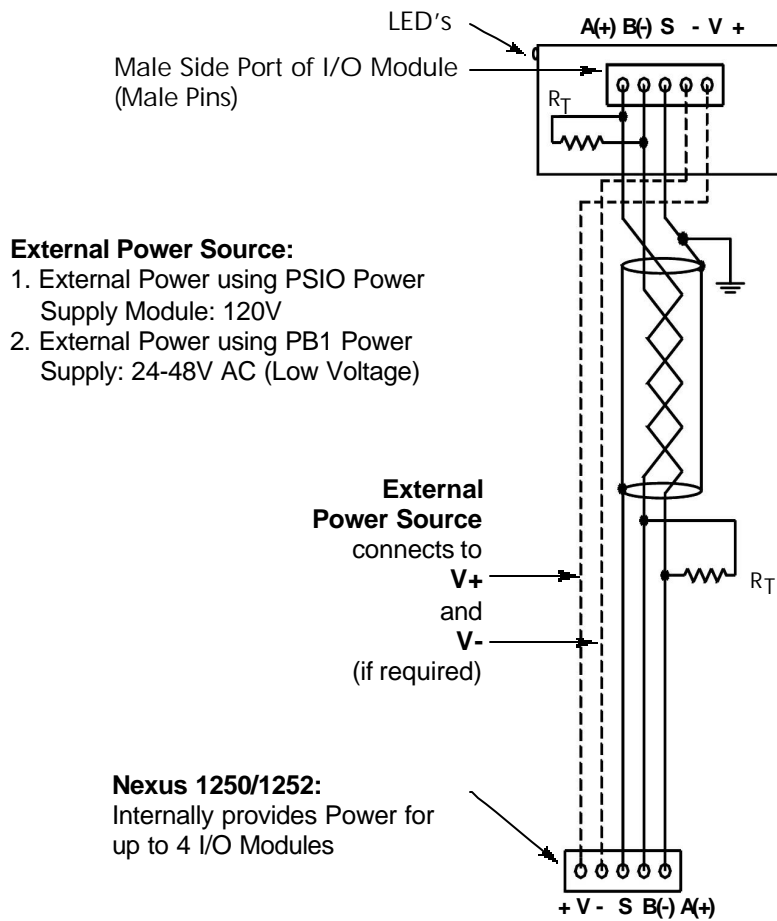


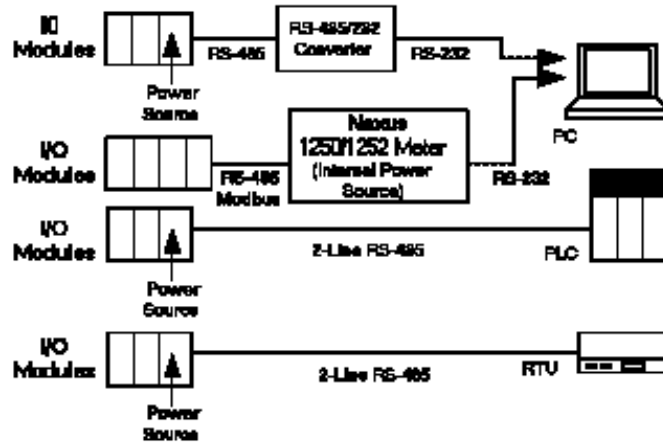
Figure 2.8: Nexus 1250/1252 with Internal Power Source Connected to I/O Module

## 2.3: Communicating with the I/O Modules

### 2.3.1: Communication Setup

- All I/O Modules can read and/or write data messages. To communicate with an I/O Module, a connection must be made with the module via Modbus Protocol. The hardware used to make the connection can take a number of different forms.

- The user can make a connection directly using a PC with appropriate terminal software. Installation is similar to that in section 2.2. A PC can be connected to IO modules using a suitable RS-485 to RS-232 converter and a power supply.
- Nexus 1250/1252 can be used to connect the I/O Module with a PC via Modbus Protocol. The Nexus has an Internal Power Supply that will support up to 4 I/O Modules. See section 2.2 for installation.



- 3 & 4. The I/O Modules with an external Power Supply can also connect directly to a PLC or an RTU with a 2-Wire RS-485 hookup. Wiring will depend on the particular unit in use. An RS-485/232 Converter may be required. Using software which **must be able to generate CRC checksum at the end of any message**, the user can interact with an IO module directly in Modbus RTU protocol. The user can write to registers (and/or) read those registers back.

Refer to Chapter 3 for Modbus Protocol functions and Chapter 4 for Communication Data Formats.

### 2.3.2: Using Nexus Communicator or Nexus Programmer Software

- Nexus Communicator or Nexus Programmer Software communicates with an I/O Module directly, whether the I/O Module is connected to a Nexus 1250/1252 meter or the I/O is a stand-alone. Below are steps required to communicate directly to the I/O Module using a PC, a power supply for the I/O Module and an RS-485/RS-232 converter.

- Install Communication Wiring**  
Direct Connection shown here.  
For more details, see section 2.2.6.



- Install Nexus Communicator software.**  
In order to communicate with an I/O module via Nexus Communicator software, you must have Nexus Communicator installed on your PC. For installation details, refer to the *Nexus Communicator User's Manual*.



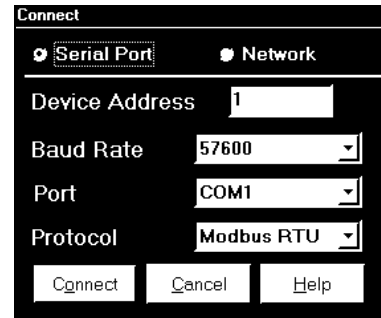
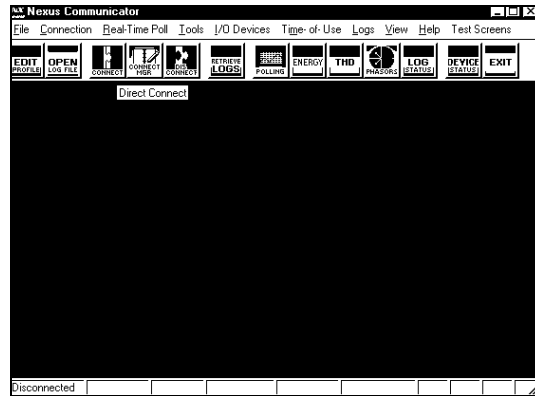
3. **Click on Nexus Communicator Icon** (located in a file on your PC) to open Nexus Communicator software. The Main screen for Nexus Communicator Software will appear on your screen.

4. **Click the Connect Icon.**  
The “Connect” screen will appear.

5. **Type Address** in Device Address window.

6. Use pull-down menus to **Input Settings** as shown. Baud Rate and Port settings can change.  
**The Protocol MUST be Modbus RTU.**

7. **Click Connect.**  
The Device Status - Direct Connect to Com 1 screen will appear showing the Boot, Run Time and Comm Status for the connected devices. (The screen creates a list if more than one device is connected.)



Electro Industries Device Status - Direct Connect to Com 1

### List of Currently Connected Devices

Device	Device Type	Boot	Run-time	DSP Boot	DSP Run-time	Comm State	DSP State
1	Digital Output Module	Comm RT:   Comm Bt:   DSP RT:   DSP Bt:	0023	123		Healthy	

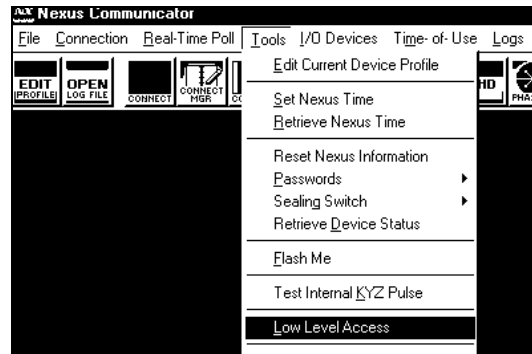
Polling Operational Mode Comm 1

OK Help

8. **Click OK.** The Main screen will reappear.

9. **Click on I/O Devices, then Tools, Low Level Access.**  
The Low Level Access screen appears.

Only available choices are highlighted and able to be selected.



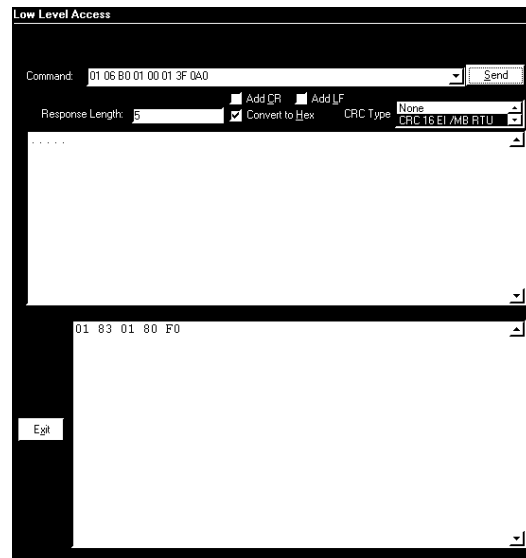
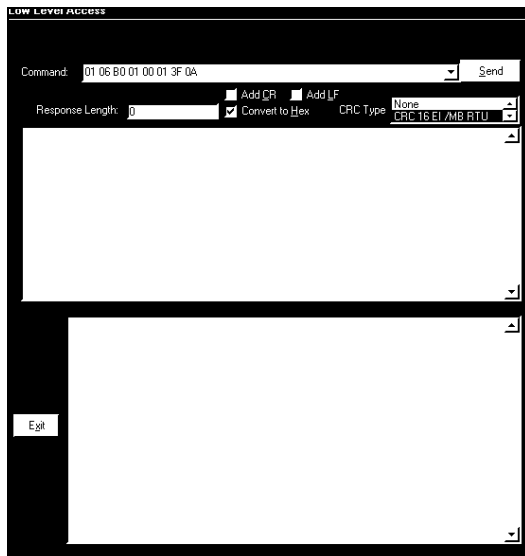
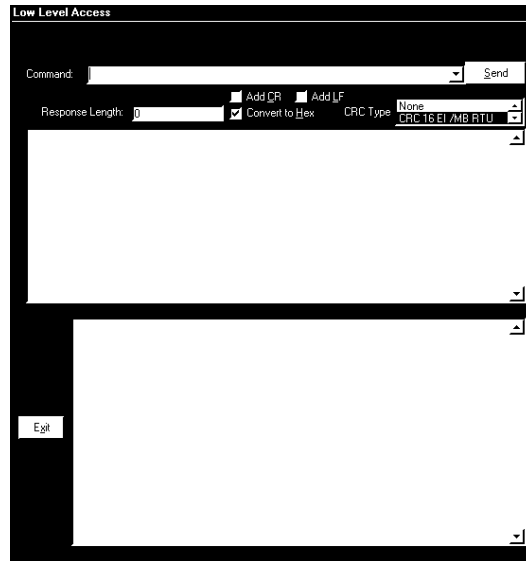
- On the Low Level Access screen, check **Convert to Hex** and from the pull-down menu, select **CRC 16EI/MB RTU**.

Now Low Level Access is ready to send and receive commands to and from the I/O Module(s) connected to the PC.

- Type a Command into the Command window. Click **SEND**.

A response will return from the I/O Module that received the command. Example screens are shown below.

**Example commands are discussed in section 2.4.**



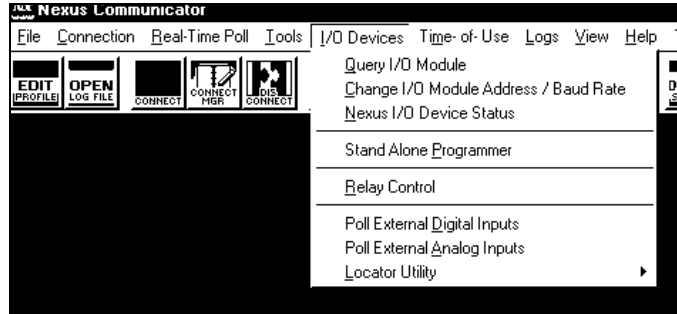
- Click **Exit** to close the screen.

**NOTE:** To use a Meter with an Internal Power Source to communicate with the I/O Modules, the user must program the meter to communicate in Modbus RTU. See sections 2.2 and 2.3 for wiring and communication. Software will vary from meter to meter. Refer to the user guide for the meter in use.

### 2.3.3: Other Communications Functions Available

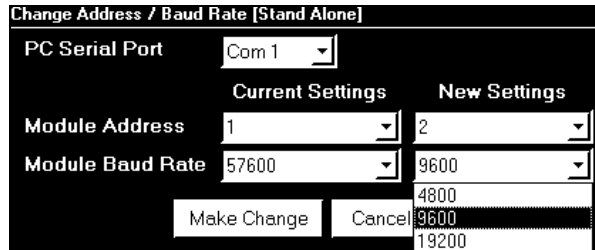
- Nexus Communicator and Nexus Programmer Software provide additional functions for the I/O Modules that can be accessed with the Tool Bar. A brief overview follows. Full details can be found in the *Nexus Communicator User Manual*. Nexus Programmer has the same functions and screens except for Log Viewer. Low Level Access (Tools Menu) is discussed in section 2.3.2.

From the **I/O Devices Menu**, several functions will be highlighted and available for Directly Connected I/O Modules. The actual function will vary depending on the particular I/O Module(s) connected.



- **Change I/O Module Address/Baud Rate:**

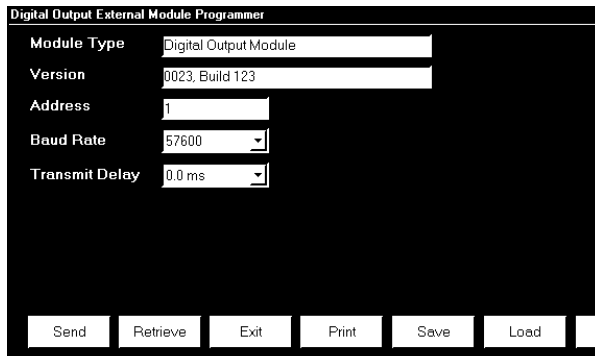
When this function is selected, this screen appears. The PC Serial Port and Current Settings appear on the screen. From pull-down menus under New Settings, select the new settings. Click Make Change or Cancel.



- **Stand Alone Programmer:**

When this function is selected, a Programmer screen for the connected I/O Module appears. The user can change the Address, Baud Rate and Transmit Delay. The user can Send/Retrieve settings to and from the I/O Module with the Send or Retrieve button. The user can Save/Load settings to or from files on the PC Disc Drive with the Save or Load button.

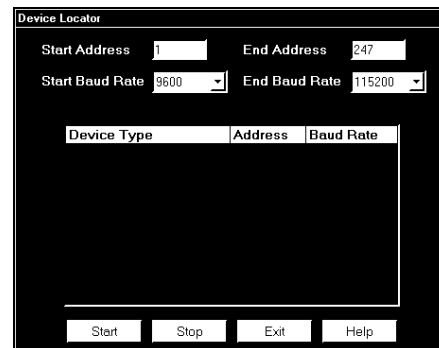
**The Send button automatically Restarts the I/O Module being changed.**



- **Device Locator:**

This screen locates Connected Devices. In the interest of time, it is best to limit the Address field as much as possible when searching for a device. (Example: Start: 230, End: 247.)

- **Click Exit to Close the Stand Alone Programmer and Device Locator screens.**



## 2.4: Example Commands

### 2.4.1: Communication Overview

- All I/Os are shipped pre-programmed with Baud Rates of 57600, Addresses and Transmit Delay Times. The Programmable Settings for the IO modules can be changed by writing new values to the Modbus Registers.

Using software which **must be able to generate CRC checksum at the end of any message**, the user can interact with an IO module directly in Modbus RTU Protocol. **The user can change the settings by writing to registers and verify the changes by reading those registers back.**

Refer to Chapter 3 for Modbus Protocol functions and Chapter 4 for Communication Data Formats.

### 2.4.2: Changing the Unit Address

- In order to change the Address, you will need to know the Address and Baud Rate of the unit. If you forget those settings, push the Reset button. The unit will run in Default Mode (Address 247, Baud Rate 57600). See Chapter 5 for more details.

#### Example 1: To change the Unit Address to 1.

Send the following data to the IO module in Default Mode.

F7 06 B0 00 00 01 (DO NOT TYPE SPACES)

F7: Unit Address 247  
06: Function Code, Preset Single Register  
B0 00: Register for Address  
00 01: New Unit Address 1  
(72 54: CRC checksum)

Reset the unit by sending the following Reset Command.  
After Reset, the Unit's Address will be 1.

F7 06 FF 81 00 01 (DO NOT TYPE SPACES)  
F7: Unit Address 247  
06: Function Code, Preset Single Register  
FF 81: Register for Reset  
00 01: Any value is OK  
(34 A8: CRC checksum)

### 2.4.3: Changing the Baud Rate

- The unit is running at 57600 Baud Rate (factory setting) or in Default Mode. If necessary, the Baud Rate can be lowered by writing the value into the proper Modbus Register.

**Example 2. To change the Baud Rate to 9600.**

Let's say the unit has an Address of 1 and is running at 57600 Baud Rate.  
Send the following data to the unit at 57600 Baud Rate.

01 06 B0 01 00 01 (DO NOT TYPE SPACES)

01: Unit Address  
06: Function Code, Preset Single Register  
B0 01: Register for Baud Rate  
00 01: Represent 9600 Baud Rate  
(3F 0A: CRC checksum)

Reset the unit by sending the following reset command. This should be sent at 57600 Baud Rate.  
After Reset, unit will run at 9600 Baud Rate.

F7 06 FF 81 00 01

**NOTE: Transmit Delay Time also can be changed in the same manner.**

## **2.4.4: Changing the Unit Address, Baud Rate and Transmit Delay Time**

**Example 3. To change all three settings by sending one command.**

Let's say the unit is in the Default Mode (Address 247, Baud Rate 57600, Transmit Delay Time 20 csec).

Send the following data. The unit will have an Address of 1, Baud Rate of 9600 and Transmit Delay Time of 0 csec.

F7 10 B0 00 00 03 06 00 01 00 01 00 00 (DO NOT TYPE SPACES)

F7: Unit Address  
10: Function Code, Preset Multiple Registers  
B0 00: Starting Address  
00 03: Number of Registers  
06: Byte count  
00 01: New Unit Address, 1  
00 01: New Baud Rate, 9600  
00 00: Delay Time, 0  
(95 75: CRC checksum)

Reset the unit by sending the following Reset Command. After Reset, the unit will run with new settings (Address 1, Baud Rate 9600 and Transmit Delay Time 0).

F7 06 FF 81 00 01 (DO NOT TYPE SPACES)



# Chapter 3

## Modbus Protocol Overview

### 3.1: Communication Packets

- Communication takes place between a Modbus Master and one or more Slaves. The Master initiates all communication by transmitting an information packet called the “request” to a specific Slave. The Slave replies with its own packet, called the “response”. A packet is a serial string of 8-bit bytes consisting of the following:

- Slave Address 1 byte
- Function Code 1 byte
- Data N bytes: high-ordered byte first, low-order byte second
- CRC (RTU Error Checksum) 2 bytes
- Dead Time 3.5 bytes transmission time

- A single packet can transmit a maximum of 127 registers.

### 3.2: Slave Address and Broadcast Request

- Each Slave device on a communication bus has its own unique address. Only the Slave addressed by a Master will respond. The response packet returned to the Master will have the same value in the Slave Address Field as the request packet. Addresses are programmable and range from 1 to 247.
- A Slave Address of 0 is a broadcast command that allows the Master to send the same packet to all devices at once. All Slaves will obey the packet’s instructions, but none will respond. The broadcast request feature is available only with function codes 6 and 10, Preset Single Registers and Preset Multiple Registers, respectively. See Tables 3.3 and 3.4.

### 3.3: Function Codes

A packet’s Function Code tells the addressed Slave what action to perform. The I/O modules support the following Modbus Function Codes:

Table 3.1: Function Codes		
Function Code		Description
Hex	Dec	
03H	3	Read Holding Registers
06H	6	Preset Single Register
10H	16	Preset Multiple Registers

#### 3.3.1: Function Code 03—Read Holding Registers

- This function allows a Master station to read one or more parameter values (data registers) from a Slave. The data registers are 16-bit (two byte) values transmitted in “Big Endian” format: high-ordered byte first, low-ordered byte second.
- The Master device sends a packet defining a start register for the Slave and the number of registers to read. The Slave responds with a packet containing the requested parameter values within the range specified in the request.
- In the following example, a Master device requests a Slave at address 01H to transmit two values beginning at Register 00001. The Slave replies with values 3031H and 3037H from Registers 00001 and 00002.

Table 3.2: Function Code 03 Example					
Master Packet	Hex	Dec	Slave Packet	Hex	Dec
Slave Address	01H	1	Slave Address	01H	1
Function Code	03H	3	Function Code	03H	3
Data Starting Address-Hi	00H	0	Byte Count	04H	4
Data Starting Address-Lo	00H	0	Data 1-Hi	30H	48
Number of Registers-Hi	00H	0	Data 1-Lo	31H	49
Number of Registers-Lo	02H	2	Data 2-Hi	30H	48
CRC-Lo	C4H	4	Data 2-Lo	37H	55
CRC-Hi	0BH	11	CRC-Lo	F1H	241
			CRC-Hi	2AH	42



### 3.3.2: Function Code 06—Preset Single Register

- This function allows a Master station to modify a single register in a Slave. The data registers are 16-bit (two byte) values transmitted high-ordered byte first, low-ordered byte second.
- In the following example, a Master device stores the value 0001H at Register 57346 in a Slave at address 01H.

Master Packet	Hex	Dec	Slave Packet	Hex	Dec
Slave Address	01H	1	Slave Address	01H	1
Function Code	06H	6	Function Code	06H	6
Data Starting Address-Hi	E0H	224	Data Starting Address-Hi	E0H	224
Data Starting Address-Lo	01H	1	Data Starting Address-Lo	01H	1
Data-Hi	00H	0	Data-Hi	00H	0
Data-Lo	01H	1	Data-Lo	01H	1
CRC-Lo	2EH	46	CRC-Lo	2EH	46
CRC-Hi	0AH	10	CRC-Hi	0AH	10

### 3.3.3: Function Code 10—Preset Multiple Registers

- This function allows a Master station to modify a group of consecutive registers in a Slave. Registers are 16-bit (two byte) values transmitted high-ordered byte first, low-ordered byte second.
- In the following example, a Master device stores the value 0001H at Register 57345, 0001H at Register 57346 and 0001H at Register 57347 in a Slave at address 01H.

### 3.4: Data Starting Address

- Range in Hex: 0000H - FFFFH
- Range in Decimal: 00001 - 65536

The Address in the Modbus Register Map Excel Spreadsheet is in Decimal.

Example: For some Scada Softwares, to read Holding Registers (3.3.1), Address Format should be: 4(XXXXX) with the XXXXX being our Decimal Address.

Table 3.4: Function Code 10 Example					
Master Packet	Hex	Dec	Slave Packet	Hex	Dec
Slave Address	01H	1	Slave Address	01H	1
Function Code	10H	16	Function Code	10H	16
Data Starting Address-Hi	E0H	224	Data Starting Address-Hi	E0H	224
Data Starting Address-Lo	01H	1	Data Starting Address-Lo	01H	1
Number of Setpoints-Hi	00H	0	Number of Setpoints-Hi	00H	0
Number of Setpoints-Lo	03H	3	Number of Setpoints-Lo	03H	3
Byte Count	06H	6	CRC-Lo	E6H	230
Data #1-Hi	00H	0	CRC-Hi	08H	8
Data #1-Lo	01H	1			
Data #2-Lo	00H	0			
Data #2-Hi	01H	1			
Data #3-Lo	00H	0			
Data #3-Hi	01H	1			
CRC-Lo	4DH	77			
CRC-Hi	46H	70			

### 3.5: CRC (Error Checksum) Algorithm

- The Cyclic Redundancy Check (CRC) field is an error checksum calculation that enables a Slave device to determine if a request packet has been corrupted during transmission.
- Every request packet transmitted from Master to Slave includes a special 16-bit value derived from a CRC-16 algorithm performed on the packet's contents. When a Slave receives a packet, it performs a CRC-16 calculation and compares the value with the one included in the request packet. If the two values do not match, the Slave will ignore the packet.
- The following is the pseudocode for calculating the 16-bit CRC:

Initialize a 16-bit register to FFFFH.  
Initialize the generator polynomial to A001H.

```

FOR n=1 to # of bytes in packet
  XOR nth data byte with the 16-bit register
  FOR bits_shifted = 1 to 8
    SHIFT 1 bit to the right
    IF (bit shifted out EQUAL 1)
      XOR generator polynomial with the 16-bit register and store result in
      the 16-bit register
    END IF
  END FOR
END FOR

```

The resulting 16-bit register contains the CRC-16 checksum.

### 3.6: Dead Time

- A Slave considers a transmission from a Master complete when it has received no data for a period of 3.5 byte transmission times—approximately 7 ms at 4800 baud and 300 microseconds at 115200 baud. If the Master transmits any gaps between bytes that are longer than this time period, the Slaves will perceive it as dead time.
- At the conclusion of the dead time, all unaddressed Slaves begin listening for a new packet from the Master.

### 3.7: Exception Response (Error Codes)

- A Slave will send its Master an Exception Response packet, if it has encountered an invalid command or other problem while carrying out the Master's instructions. The function code of the response will have the most significant bit set. The Data field of the Exception Response contains an Error Code specific to the type of problem.
- Table 3.5 below lists the different Error Codes supported by the I/O Modules.

Error Code	Name	Description
01	Illegal Function	The Slave does not support the function code of the transmitted request packet.
02	Illegal Data Address	The Slave does not recognize the address in the data field of the transmitted request packet.
03	Illegal Data Value	The value referenced in the transmitted request packet is not supported by the register on the Slave.
06	Busy, Rejected Packet	The Slave is busy performing a long operation and can not receive the request packet.

- In the following example, a Master Device requests a Slave at address 01H to transmit the value at Register 00256. The Slave replies with an error, indicating that it is busy.

<b>Table 3.6: Exception Response Example</b>					
<b>Master Packet</b>			<b>Slave Packet</b>		
<b>Meaning</b>	<b>Hex</b>	<b>Dec</b>	<b>Meaning</b>	<b>Hex</b>	<b>Dec</b>
Address	01H	1	Address	01H	1
Function Code	03H	3	Function Code	83H	131
Data Starting Address-Hi	01H	1	Error Code	06H	6
Data Starting Address-Lo	00H	0	CRC-Lo	C1H	193
Number of Registers-Hi	00H	0	CRC-Hi	32H	50
Number of Registers-Lo	01H	1			
CRC-Lo	85H	133			
CRC-Hi	F6H	246			

## Chapter 4

### Communication Data Formats

#### 4.1: Type F1 Null Terminated ASCII String (00001 - 00072)

- Length: Depends on the reading.
- Each register contains two bytes. Each byte stands for an ASCII character. The printable portion of the string is terminated with a Null character (ASCII 00H). Any characters after the terminating Null are ignored.

Example for the 0-1mAON4 (Other examples found in Module chapters):  
Registers 00001 – 00008, the Device Name, might contain the following data:

<b>Addr (Dec)</b>	00001		00002		00003		00004		00005		00006		00007		00008	
<b>Value</b>	3031H		3231H		2030H		2D31H		206DH		4120H		4F75H		7400H	
<b>Bytes</b>	30H	31H	32H	31H	20H	30H	2DH	31H	20H	20H	31H	6DH	41H	4FH	4EH	34H
<b>ASCII</b>	'0'	'1'	'2'	'1'	'0'	'1'	'0'	'4'	' '	' '	'1'	'm'	'A'	'O'	'N'	'4'
<b>Register</b>	"01"		"21"		"01"		"04"		" "		"1m"		"AO"		"N4"	
<b>String</b>	"01210104 1mAON4"															

#### 4.2: Type F2 Fixed Length ASCII String (00073 - 00074)

- Length: Depends on the reading.
- Range: 9.9.9.9 / 0.0.0.0
- Unit: 0.0.0.1 version
- Each register contains two bytes. Each byte stands for an ASCII character. All bytes are significant. There is no terminating character.

Example:  
Registers 00073 – 00074, the Device Name, might contain the following data:

<b>Addr (Dec)</b>	00073		00074	
<b>Value</b>	3030H		3134H	
<b>Bytes</b>	30H	30H	31H	34H
<b>ASCII</b>	'0'	'0'	'1'	'4'
<b>Register</b>	"00"		"14"	
<b>String</b>	"0014"			

### 4.3: Type F3 Build Number (00075 - 00076)

- Length: 2 Registers (8 bytes)
- Range: 4,297,496,295 / 0.0.0.0
- Unit: 1 build
  
- These registers together are a four byte unsigned integer.

Example:

Registers 00075 – 00076, the Device Firmware Build Number, might contain the following data:

<b>Addr (Decimal)</b>	00075	00076
<b>Value</b>	0000H	0067H
<b>4 Byte Unsigned Integer (Hex)</b>	00000067H	
<b>4 Byte Unsigned Integer (Decimal)</b>	103	
<b>Build Number</b>	103	

#### 4.4: Type F4 Address (45057)

- Length: 1 Register (2 Bytes)
- Range: 1 - 247
  
- This register contains a 1 byte unsigned integer. The value of the high order byte is ignored.

Example:  
Register 45057, Address, might contain the following data:

<b>Address (Decimal)</b>	45057	
<b>Value</b>	0003H	
<b>Bytes (Hex)</b>	00H	03H
<b>1 Byte Unsigned Integer (Decimal)</b>	XX	3
<b>Address</b>	3	

#### 4.5: Type F5 Baud Rate (45058)

- Length: 1 Register (2 Bytes)
  
- This register contains a 1 byte enumeration. The value of the high order byte is ignored. The value of the low order byte refers to an enumerated list of choices, as follows:
  - 0 4800 Baud
  - 1 9600 Baud
  - 2 19200 Baud
  - 3 38400 Baud (Not Used)
  - 4 57600 Baud
  - 5 115200 Baud (Not Used)

Example:

Register 45058, Address, might contain the following data:

<b>Address (Decimal)</b>	45058	
<b>Value</b>	0003H	
<b>Bytes (Hex)</b>	00H	03H
<b>1 Byte Unsigned Integer (Decimal)</b>	XX	3
<b>Baud Rate</b>	19200 Baud	

#### 4.6: Type F6 Transmit Delay Time (45059)

- Length: 1 Register (2 Bytes)
- Range: 2.55 sec / 0.00 sec
- Unit: 0.01 sec
  
- This register contains a 1 byte unsigned integer. The value of the high order byte is ignored.

Example:

Register 45059, Transmit Delay Time, might contain the following data:

<b>Address (Decimal)</b>	45059	
<b>Value</b>	0003H	
<b>Bytes (Hex)</b>	00H	03H
<b>1 Byte Unsigned Integer (Decimal)</b>	XX	3
<b>Transmit Delay Time</b>	0.03 sec	



## 4.7: Type F7 Device Status (65409)

■ Length: 1 Register (2 Bytes)

■ This Register is a bit-mapped register containing Device Status information. The device is fully functional if all the bits are “0”. The presence of any “1” bit indicates some problem or operational state other than normal operation.

- |          |                                      |  |
|----------|--------------------------------------|--|
| • Bit 0  | EEProm Fail                          | A read or write of the EEPROM failed.  |
| • Bit 1  | Communication Settings Checksum Fail | The checksum for the Communication Settings does not pass.                       |
| • Bit 2  | Programmable Settings Checksum Fail  | The checksum for the Programmable Settings does not pass.                        |
| • Bit 3  | Invalid Communication Settings       | One or more of the Communication Settings is not valid.                          |
| • Bit 4  | Invalid Programmable Settings        | One or more of the Programmable Settings is not valid.                           |
| • Bit 5  | Programming Changed                  | One or more of the Programmable Settings have been changed since initialization. |
| • Bit 6  | Forced Default                       | The reset switch was detected as pressed on startup.                             |
| • Bit 9  | Calibration                          | The unit is in Calibration Mode.   |
| • Bit 10 | Test Output                          | The unit is in Test Output Mode.   |
| • Bit 11 | Normal Disabled                      | Normal function of the unit is disabled.   |

Example:  
 Register 65409, Device Status, might contain the following data:

<b>Addr (Dec)</b>	65409															
<b>Value</b>	8006H															
<b>Bytes</b>	80H										06H					
<b>Bits</b>	1	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
<b>Meaning</b>	Normal Disabled													Invalid Setting	Cksm Fail	
<b>Interpretation</b>	Normal Function is Disabled; Programmable Settings contain invalid settings and failed the checksum.															

#### 4.8: Type F8 Device Reset (65410)

- Length: 1 Register (2 Bytes)
- The format of this register does not matter. Any write to this register will reset the device.

#### 4.9: Type F9 Device Serial Number (65535 - 65536)

- Length: 2 Registers (4 bytes)
- Range: 99,999,999 / 0
- Unit: 1
- These registers contain 4 bytes of Packed BCD. Each register contains 2 bytes. Each byte contains 2 nibbles. Each nibble represents a decimal digit from 0-9. All together, there are 8 nibbles and therefore an 8-digit decimal number can be represented.

Example:  
 Registers 65535 and 65536, Device Serial Number, might contain the following data:

<b>Address (Decimal)</b>	65535				65536			
<b>Value</b>	0001H				0945H			
<b>Bytes</b>	00H		01H		09H		45H	
<b>Nibbles</b>	0H	0H	0H	1H	0H	9H	4H	5H
<b>Digit</b>	0	0	0	1	0	9	4	5
<b>Serial Number</b>	10945							

#### 4.10: Type F10 Device Options (00077)

- Length: 1 Register (2 Bytes)
- This register contains a 2 byte enumeration. The value refers to an enumerated list of choices, as follows:
  - 0 = 4 Channel Device
  - 1 = 8 Channel Device

Example:

Writing to Register 00077, Device Options, might contain data as follows:

<b>Address (Decimal)</b>	00077
<b>Value</b>	0001H
<b>Option</b>	Device is 8 Channel

#### NOTES:

1. Changes to the Programmable Settings do not take effect until after the device is reset.



# Chapter 5

## Operations and Default Mode

### 5.1: Operations

- An I/O Module gathers inputs or produces outputs for a particular application to provide additional functionality to a Master. At the Master's read or write request, the I/O Module reacts to the Master via Modbus Protocol.

Normal Mode is the standard mode of operation for the I/O Modules. If all settings and configurations are correct and the hardware is working correctly, the I/O Module will continue to operate in Normal Mode.

There are a number of occurrences that can prevent the I/O Module from operating in Normal Mode. Those occurrences are noted below in Section 5.2: Default Mode.

Normal Mode for each type of I/O Module is unique. Normal Mode for each I/O Module will be detailed in the following chapters. Specifications and examples of normal operation and applications will be provided where needed.

### 5.2: Default Mode

- When an I/O Module cannot run in Normal Mode, it will run in Default Mode.

Normal Mode is prevented by:

- EEProm Failure
- Failure of Communication Settings Checksum
- Failure of Programmable Settings Checksum
- Invalid Communications Settings
- Invalid Programmable Settings
- Reset Switch triggered during Initialization
- Any modification to the Programmable Settings
- Calibration Mode (Analog Input/Output Module)
- Test Output Mode (Analog Input/Output Module)

Invalid Programmable Settings are:

- An Address outside the range of 1-247
- A Baud Rate not supported by the device

■ When operating in Default Mode, the following happens:

The device runs a 30-second timer. This timer is reloaded with every valid request received.

If the timer runs out, the device will reset.

The commands used in Normal Mode will be ignored when received.

Bits in the Device Status Registers reflect this state and the reason(s) for the state.

The device will start in Normal Mode after reset, if nothing prevents it from doing so.

# Chapter 6

## Analog Output Modules

### 6.1: Overview

- The Analog Transducer Signal Output Modules (0-1mA or 4-20mA) are available in either 4- or 8-channel configuration. Maximum registers per request, read or write, is 17 registers.
- The Modbus Map for the Analog Output I/O Modules is in Chapter 7.

### 6.2: Analog Output Specifications

ANALOG TRANSDUCER SIGNAL OUTPUT MODULES SPECIFICATIONS	
Model Numbers	1mAON4: 4-Channel Analog Output, 0-1mA
	1mAON8: 8-Channel Analog Output, 0-1mA
	20mAON4: 4-Channel Analog Output, 4-20mA
	20mAON8: 8-Channel Analog Output, 4-20mA
Accuracy	0.1% of Full Scale
Scaling	Programmable
Communication	RS-485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 57600
Power Requirement	15-20V DC at 50-200mA
Operating Temperature	-20°C to 79°C / -4°F to +158°F
Maximum Load Impedance	0-1mA: 10k Ω; 4-20mA: 500 Ω
Factory Settings	Modbus Address: 1mAON4, 0-1mA: 128 1mAON8, 0-1mA: 128 20mAON4, 4-20mA: 132 20mAON8, 4-20mA: 132
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20 csec

### 6.3: Normal Mode

- Normal Mode is the same for the 0-1mA and the 4-20mA Analog Output Modules except for the number of processes performed by the modules.

Both devices:

1. Accept new values through communication.
2. Output current loops scaled from previously accepted values.

The 0-1mA module includes one more process in its Normal Mode:

3. Read and average the A/D and adjust values for Process 2 above

- The device will operate with the following default parameters:

Address	247 (F7H)
Baud Rate	57600 Baud
Transmit Delay Time	0

- Normal Operation is prevented by a number of occurrences. See Chapter 5 for details.

#### 6.3.1: Output Value, Channels 1-8

- Registers 04097-04112 (0x01000-0x01100).

Each channel has two registers. The reading has a 4-byte signed integer. The range is +2,147,483,647 / -2,147,483,648. The user defines the unit. These values represent inputs from outside the device. The scale and units for an Output Value register should be consistent with those as programmed in the Scale Hi Value and Scale Lo Value registers for a given channel.

#### 6.3.2: Scale Hi/Lo Value, Channels 1-8

- Registers 45073-45104 (0x0B010-0x0B02F).

Each channel has two registers. The reading has a 4-byte signed integer. The range is +2,147,483,647 / -2,147,483,648. The user defines the unit. These values are used with Scale Hi/Lo Percentage Values in order to find proper current output for a given channel.

#### 6.3.3: Scale Hi/Lo Percent, Channels 1-8

- Registers 45105-45120 (0x0B030-0x0B03F).

Each register contains a 2-byte signed integer. The range is +327.67 % - -327.67 % and the unit is 0.01 %. These values are used with Scale Hi/Lo Value Registers in order to find proper current output for a given channel.



### 6.3.4: Registers for Internal Calculation

- The following registers are used by the I/O Module for internal calculation to calculate the percentage of the Input Values.

DA Value, Channels 1-8	Registers 04113-04120 (0x01010-0x01017)
Target Thermal Average A/D Value, Channels 1-8	Registers 04121-04128 (0x01018-0x0101F)
Thermal Average A/D Value, Channels 1-8	Registers 04129-04136 (0x01020-0x01027)
Thermal Average A/D Value, Reference	Register 04137 (0x01028)

### 6.3.5: Registers for Calibration

- The following registers are used by the I/O Module for device calibration. This calibration is done in the factory, since it requires extremely high accuracy. Therefore, these registers will not be explained in this manual.

Calibrate Hi Percent, Channels 1-8	Registers 45121-45128 (0x0B040-0x0B047)
Calibrate Lo Percent, Channels 1-8	Registers 45129-04136 (0x0B048-0x0B04F)
Calibrate Hi Therm Avg A/D Value, Channels 1-8	Registers 45137-45144 (0x0B050-0x0B057)
Calibrate Lo Therm Avg A/D Value, Channels 1-8	Registers 45145-45152 (0x0B058-0x0B05F)
Calibration Mode	Register 57345 (0x0E000)
Test Output	Register 57346 (0x0E001)



# Chapter 7

## Analog Output Modbus Register Maps

### 7.1: Modbus Register Maps

- The Analog Output Modbus Register Maps begin on page 7-3. There are separate maps for the 0-1mA Analog Output Module I/O Module and for the 4-20mA Output Module.

Maximum registers per request, read or write, is 17 registers.

- **Columns**

See Chapter 4 for a detailed description of Communication Formats referred to in the the Register Map's "Type" column. See the Table of Contents for a list of the Register Map's "Types" and their page location in Chapter 4.

The R/W column indicates the Read/Write function of that particular register. An R, W or R/W in the column indicates the following:

R	=	Read Only
W	=	Write Only
R/W	=	Read and Write



### 0-1mA 4- and 8-Channel Analog Output Modbus Map

Address	Description	Range	Units	Type	R/W	Notes
<b>Device Identification Block</b>						
00001-00008	Device Name			F1	R	
00009-00016	Firmware Variation String 1			F1	R	
00017-00024	Firmware Variation String 2			F1	R	
00025-00032	Firmware Variation String 3			F1	R	
00033-00040	Firmware Variation String 4			F1	R	
00041-00048	Firmware Variation String 5			F1	R	
00049-00056	Firmware Variation String 6			F1	R	
00057-00064	Firmware Variation String 7			F1	R	
00065-00072	Firmware Variation String 8			F1	R	
00073-00074	Device Firmware Version Number	9.9.9.9 / 0.0.0.0	0.0.0.1 version	F2	R	
00075-00076	Device Firmware Build Number	4,297,496,295 / 0	1 build	F3	R	
00077	Device Option			F10	R	
<b>Dynamic Data Block</b>						
04097-04098	Output Value, Channel 1	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04099-04100	Output Value, Channel 2	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04101-04102	Output Value, Channel 3	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04103-04104	Output Value, Channel 4	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04105-04106	Output Value, Channel 5	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04107-04108	Output Value, Channel 6	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04109-04110	Output Value, Channel 7	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04111-04112	Output Value, Channel 8	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04113	DA Value, Channel 1	4095 / 0	1 count D/A		R	
04114	DA Value, Channel 2	4095 / 0	1 count D/A		R	
04115	DA Value, Channel 3	4095 / 0	1 count D/A		R	
04116	DA Value, Channel 4	4095 / 0	1 count D/A		R	
04117	DA Value, Channel 5	4095 / 0	1 count D/A		R	
04118	DA Value, Channel 6	4095 / 0	1 count D/A		R	
04119	DA Value, Channel 7	4095 / 0	1 count D/A		R	
04120	DA Value, Channel 8	4095 / 0	1 count D/A		R	
04121	Target Thermal Average A/D Value, Channel 1	+4095.875 / -4096.000	1/8 count A/D		R	
04122	Target Thermal Average A/D Value, Channel 2	+4095.875 / -4096.000	1/8 count A/D		R	
04123	Target Thermal Average A/D Value, Channel 3	+4095.875 / -4096.000	1/8 count A/D		R	
04124	Target Thermal Average A/D Value, Channel 4	+4095.875 / -4096.000	1/8 count A/D		R	
04125	Target Thermal Average A/D Value, Channel 5	+4095.875 / -4096.000	1/8 count A/D		R	
04126	Target Thermal Average A/D Value, Channel 6	+4095.875 / -4096.000	1/8 count A/D		R	
04127	Target Thermal Average A/D Value, Channel 7	+4095.875 / -4096.000	1/8 count A/D		R	
04128	Target Thermal Average A/D Value, Channel 8	+4095.875 / -4096.000	1/8 count A/D		R	
04129	Thermal Average A/D Value, Channel 1	+4095.875 / -4096.000	1/8 count A/D		R	

### 0-1mA 4- and 8-Channel Analog Output Modbus Map

Address	Description	Range	Units	Type	R/W	Notes
04130	Thermal Average A/D Value, Channel 2	+4095.875 / -4096.000	1/8 count A/D		R	
04131	Thermal Average A/D Value, Channel 3	+4095.875 / -4096.000	1/8 count A/D		R	
04132	Thermal Average A/D Value, Channel 4	+4095.875 / -4096.000	1/8 count A/D		R	
04233	Thermal Average A/D Value, Channel 5	+4095.875 / -4096.000	1/8 count A/D		R	
04134	Thermal Average A/D Value, Channel 6	+4095.875 / -4096.000	1/8 count A/D		R	
04135	Thermal Average A/D Value, Channel 7	+4095.875 / -4096.000	1/8 count A/D		R	
04136	Thermal Average A/D Value, Channel 8	+4095.875 / -4096.000	1/8 count A/D		R	
04137	Thermal Average A/D Value, Reference	+4095.875 / -4096.000	1/8 count A/D		R	
<b>Programmable Settings Block</b>						
45057	Address	1 - 247		F4		1
45058	Baud Rate			F5		1
45059	Transmit Delay Time	2.55 sec / 0.00 sec	0.01 sec	F6		1
45073-45074	Scale Hi Value, Channel 1	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45075-45076	Scale Hi Value, Channel 2	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45077-45078	Scale Hi Value, Channel 3	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45079-45080	Scale Hi Value, Channel 4	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45081-45082	Scale Hi Value, Channel 5	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45083-45084	Scale Hi Value, Channel 6	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45085-45086	Scale Hi Value, Channel 7	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45087-45088	Scale Hi Value, Channel 8	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45089-45090	Scale Lo Value, Channel 1	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45091-45092	Scale Lo Value, Channel 2	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45093-45094	Scale Lo Value, Channel 3	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45095-45096	Scale Lo Value, Channel 4	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45097-45098	Scale Lo Value, Channel 5	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45099-45100	Scale Lo Value, Channel 6	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45101-45102	Scale Lo Value, Channel 7	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45103-45104	Scale Lo Value, Channel 8	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45105	Scale Hi Percent, Channel 1	+327.67 % / - 327.68 %	0.01 %		R/W	1
45106	Scale Hi Percent, Channel 2	+327.67 % / - 327.68 %	0.01 %		R/W	1
45107	Scale Hi Percent, Channel 3	+327.67 % / - 327.68 %	0.01 %		R/W	1
45108	Scale Hi Percent, Channel 4	+327.67 % / - 327.68 %	0.01 %		R/W	1
45109	Scale Hi Percent, Channel 5	+327.67 % / - 327.68 %	0.01 %		R/W	1
45110	Scale Hi Percent, Channel 6	+327.67 % / - 327.68 %	0.01 %		R/W	1
45111	Scale Hi Percent, Channel 7	+327.67 % / - 327.68 %	0.01 %		R/W	1
45112	Scale Hi Percent, Channel 8	+327.67 % / - 327.68 %	0.01 %		R/W	1
45113	Scale Lo Percent, Channel 1	+327.67 % / - 327.68 %	0.01 %		R/W	1
45114	Scale Lo Percent, Channel 2	+327.67 % / - 327.68 %	0.01 %		R/W	1
45115	Scale Lo Percent, Channel 3	+327.67 % / - 327.68 %	0.01 %		R/W	1

### 0-1mA 4- and 8-Channel Analog Output Modbus Map

Address	Description	Range	Units	Type	R/W	Notes
45116	Scale Lo Percent, Channel 4	+327.67 % / - 327.68 %	0.01 %		R/W	1
45117	Scale Lo Percent, Channel 5	+327.67 % / - 327.68 %	0.01 %		R/W	1
45118	Scale Lo Percent, Channel 6	+327.67 % / - 327.68 %	0.01 %		R/W	1
45119	Scale Lo Percent, Channel 7	+327.67 % / - 327.68 %	0.01 %		R/W	1
45120	Scale Lo Percent, Channel 8	+327.67 % / - 327.68 %	0.01 %		R/W	1
45121	Calibrate Hi Percent, Channel 1	+327.67 % / - 327.68 %	0.01 %		R/W	1
45122	Calibrate Hi Percent, Channel 2	+327.67 % / - 327.68 %	0.01 %		R/W	1
45123	Calibrate Hi Percent, Channel 3	+327.67 % / - 327.68 %	0.01 %		R/W	1
45124	Calibrate Hi Percent, Channel 4	+327.67 % / - 327.68 %	0.01 %		R/W	1
45125	Calibrate Hi Percent, Channel 5	+327.67 % / - 327.68 %	0.01 %		R/W	1
45126	Calibrate Hi Percent, Channel 6	+327.67 % / - 327.68 %	0.01 %		R/W	1
45127	Calibrate Hi Percent, Channel 7	+327.67 % / - 327.68 %	0.01 %		R/W	1
45128	Calibrate Hi Percent, Channel 8	+327.67 % / - 327.68 %	0.01 %		R/W	1
45129	Calibrate Lo Percent, Channel 1	+327.67 % / - 327.68 %	0.01 %		R/W	1
45130	Calibrate Lo Percent, Channel 2	+327.67 % / - 327.68 %	0.01 %		R/W	1
45131	Calibrate Lo Percent, Channel 3	+327.67 % / - 327.68 %	0.01 %		R/W	1
45132	Calibrate Lo Percent, Channel 4	+327.67 % / - 327.68 %	0.01 %		R/W	1
45133	Calibrate Lo Percent, Channel 5	+327.67 % / - 327.68 %	0.01 %		R/W	1
45134	Calibrate Lo Percent, Channel 6	+327.67 % / - 327.68 %	0.01 %		R/W	1
45135	Calibrate Lo Percent, Channel 7	+327.67 % / - 327.68 %	0.01 %		R/W	1
45136	Calibrate Lo Percent, Channel 8	+327.67 % / - 327.68 %	0.01 %		R/W	1
45137	Calibrate Hi Thermal Average A/D Value, Channel 1	+4095.875 / -4096.000	1/8 count A/D		R	1
45138	Calibrate Hi Thermal Average A/D Value, Channel 2	+4095.875 / -4096.000	1/8 count A/D		R	1
45139	Calibrate Hi Thermal Average A/D Value, Channel 3	+4095.875 / -4096.000	1/8 count A/D		R	1
45140	Calibrate Hi Thermal Average A/D Value, Channel 4	+4095.875 / -4096.000	1/8 count A/D		R	1
45141	Calibrate Hi Thermal Average A/D Value, Channel 5	+4095.875 / -4096.000	1/8 count A/D		R	1
45142	Calibrate Hi Thermal Average A/D Value, Channel 6	+4095.875 / -4096.000	1/8 count A/D		R	1
45143	Calibrate Hi Thermal Average A/D Value, Channel 7	+4095.875 / -4096.000	1/8 count A/D		R	1
45144	Calibrate Hi Thermal Average A/D Value, Channel 8	+4095.875 / -4096.000	1/8 count A/D		R	1
45145	Calibrate Lo Thermal Average A/D Value, Channel 1	+4095.875 / -4096.000	1/8 count A/D		R	1
45146	Calibrate Lo Thermal Average A/D Value, Channel 2	+4095.875 / -4096.000	1/8 count A/D		R	1
45147	Calibrate Lo Thermal Average A/D Value, Channel 3	+4095.875 / -4096.000	1/8 count A/D		R	1
45148	Calibrate Lo Thermal Average A/D Value, Channel 4	+4095.875 / -4096.000	1/8 count A/D		R	1
45149	Calibrate Lo Thermal Average A/D Value, Channel 5	+4095.875 / -4096.000	1/8 count A/D		R	1
45150	Calibrate Lo Thermal Average A/D Value, Channel 6	+4095.875 / -4096.000	1/8 count A/D		R	1
45151	Calibrate Lo Thermal Average A/D Value, Channel 7	+4095.875 / -4096.000	1/8 count A/D		R	1
45152	Calibrate Lo Thermal Average A/D Value, Channel 8	+4095.875 / -4096.000	1/8 count A/D		R	1
<b>Action Block</b>						
57345	Calibration Mode				W	

## 0-1mA 4- and 8-Channel Analog Output Modbus Map

Address	Description	Range	Units	Type	R/W	Notes
57346	Test Output				R/W	
<b>Device Status Block</b>						
65409	Device Status			F7	R	
65410	Device Reset			F8	W	
65535-65536	Device Serial Number	99999999 / 0	1	F9	R	



## 4-20mA 4- and 8-Channel Analog Output Modbus Map

Address	Description	Range	Units	Type	R/W	Notes
<b>Device Identification Block</b>						
00001-00008	Device Name			F1	R	
00009-00016	Firmware Variation String 1			F1	R	
00017-00024	Firmware Variation String 2			F1	R	
00025-00032	Firmware Variation String 3			F1	R	
00033-00040	Firmware Variation String 4			F1	R	
00041-00048	Firmware Variation String 5			F1	R	
00049-00056	Firmware Variation String 6			F1	R	
00057-00064	Firmware Variation String 7			F1	R	
00065-00072	Firmware Variation String 8			F1	R	
00073-00074	Device Firmware Version Number	9.9.9.9 / 0.0.0.0	0.0.0.1 version	F2	R	
00075-00076	Device Firmware Build Number	4,297,496,295 / 0	1 build	F3	R	
00078	Device Option			F10	R	
<b>Dynamic Data Block</b>						
04097-04098	Output Value, Channel 1	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04099-04100	Output Value, Channel 2	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04101-04102	Output Value, Channel 3	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04103-04104	Output Value, Channel 4	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04105-04106	Output Value, Channel 5	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04107-04108	Output Value, Channel 6	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04109-04110	Output Value, Channel 7	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
04111-04112	Output Value, Channel 8	+2,147,483,647 / -2,147,483,648	1 unit		R/W	
<b>Programmable Settings Block</b>						
45057	Address	1 - 247		F4		1
45058	Baud Rate			F5		1
45059	Transmit Delay Time	2.55 sec / 0.00 sec	0.01 sec	F6		1
45073-45074	Scale Hi Value, Channel 1	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45075-45076	Scale Hi Value, Channel 2	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45077-45078	Scale Hi Value, Channel 3	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45079-45080	Scale Hi Value, Channel 4	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45081-45082	Scale Hi Value, Channel 5	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45083-45084	Scale Hi Value, Channel 6	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45085-45086	Scale Hi Value, Channel 7	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45087-45088	Scale Hi Value, Channel 8	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45089-45090	Scale Lo Value, Channel 1	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45091-45092	Scale Lo Value, Channel 2	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45093-45094	Scale Lo Value, Channel 3	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45095-45096	Scale Lo Value, Channel 4	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45097-45098	Scale Lo Value, Channel 5	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1

### 4-20mA 4- and 8-Channel Analog Output Modbus Map

Address	Description	Range	Units	Type	R/W	Notes
45099-45100	Scale Lo Value, Channel 6	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45101-45102	Scale Lo Value, Channel 7	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45103-45104	Scale Lo Value, Channel 8	+2,147,483,647 / -2,147,483,648	1 unit		R/W	1
45105	Scale Hi Percent, Channel 1	+327.67 % / - 327.68 %	0.01 %		R/W	1
45106	Scale Hi Percent, Channel 2	+327.67 % / - 327.68 %	0.01 %		R/W	1
45107	Scale Hi Percent, Channel 3	+327.67 % / - 327.68 %	0.01 %		R/W	1
45108	Scale Hi Percent, Channel 4	+327.67 % / - 327.68 %	0.01 %		R/W	1
45109	Scale Hi Percent, Channel 5	+327.67 % / - 327.68 %	0.01 %		R/W	1
45110	Scale Hi Percent, Channel 6	+327.67 % / - 327.68 %	0.01 %		R/W	1
45111	Scale Hi Percent, Channel 7	+327.67 % / - 327.68 %	0.01 %		R/W	1
45112	Scale Hi Percent, Channel 8	+327.67 % / - 327.68 %	0.01 %		R/W	1
45113	Scale Lo Percent, Channel 1	+327.67 % / - 327.68 %	0.01 %		R/W	1
45114	Scale Lo Percent, Channel 2	+327.67 % / - 327.68 %	0.01 %		R/W	1
45115	Scale Lo Percent, Channel 3	+327.67 % / - 327.68 %	0.01 %		R/W	1
45116	Scale Lo Percent, Channel 4	+327.67 % / - 327.68 %	0.01 %		R/W	1
45117	Scale Lo Percent, Channel 5	+327.67 % / - 327.68 %	0.01 %		R/W	1
45118	Scale Lo Percent, Channel 6	+327.67 % / - 327.68 %	0.01 %		R/W	1
45119	Scale Lo Percent, Channel 7	+327.67 % / - 327.68 %	0.01 %		R/W	1
45120	Scale Lo Percent, Channel 8	+327.67 % / - 327.68 %	0.01 %		R/W	1
45121	Calibrate Hi Percent, Channel 1	+327.67 % / - 327.68 %	0.01 %		R/W	1
45122	Calibrate Hi Percent, Channel 2	+327.67 % / - 327.68 %	0.01 %		R/W	1
45123	Calibrate Hi Percent, Channel 3	+327.67 % / - 327.68 %	0.01 %		R/W	1
45124	Calibrate Hi Percent, Channel 4	+327.67 % / - 327.68 %	0.01 %		R/W	1
45125	Calibrate Hi Percent, Channel 5	+327.67 % / - 327.68 %	0.01 %		R/W	1
45126	Calibrate Hi Percent, Channel 6	+327.67 % / - 327.68 %	0.01 %		R/W	1
45127	Calibrate Hi Percent, Channel 7	+327.67 % / - 327.68 %	0.01 %		R/W	1
45128	Calibrate Hi Percent, Channel 8	+327.67 % / - 327.68 %	0.01 %		R/W	1
45129	Calibrate Lo Percent, Channel 1	+327.67 % / - 327.68 %	0.01 %		R/W	1
45130	Calibrate Lo Percent, Channel 2	+327.67 % / - 327.68 %	0.01 %		R/W	1
45131	Calibrate Lo Percent, Channel 3	+327.67 % / - 327.68 %	0.01 %		R/W	1
45132	Calibrate Lo Percent, Channel 4	+327.67 % / - 327.68 %	0.01 %		R/W	1
45133	Calibrate Lo Percent, Channel 5	+327.67 % / - 327.68 %	0.01 %		R/W	1
45134	Calibrate Lo Percent, Channel 6	+327.67 % / - 327.68 %	0.01 %		R/W	1
45135	Calibrate Lo Percent, Channel 7	+327.67 % / - 327.68 %	0.01 %		R/W	1
45136	Calibrate Lo Percent, Channel 8	+327.67 % / - 327.68 %	0.01 %		R/W	1
<b>Action Block</b>						
57345	Calibration Mode				W	
<b>Device Status Block</b>						
65409	Device Status			F7	R	

## 4-20mA 4- and 8-Channel Analog Output Modbus Map

Address	Description	Range	Units	Type	R/W	Notes
65410	Device Reset			F8	W	
65535-65536	Device Serial Number	99999999 / 0	1	F9	R	

# Chapter 8

## Analog Input Modules

### 8.1: Overview

- The Analog Input Modules are available in 8-channel configuration. The model numbers are listed in the table below. Maximum registers per request, read or write, is 17 registers.
- All inputs share a single common point. This is also an isolated connection (from ground).
- The Modbus Map for the Analog Input I/O Modules is in Chapter 9.

### 8.2: Analog Input Specifications

ANALOG INPUT MODULES SPECIFICATIONS	
Model Numbers	8AI1: 8-Channel Analog Input, 0-1mA
	8AI2: 8-Channel Analog Input, 0-20mA
	8AI3: 8-Channel Analog Input, 0-5V DC
	8AI4: 8-Channel Analog Input, 0-10V DC
Accuracy	0.1% of Full Scale
Scaling	Programmable
Communication	RS-485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 57600
Power Requirement	15-20V DC at 50-200mA
Operating Temperature	-20°C to 79°C / -4°F to +158°F
Maximum Load Impedance	0-1mA: 10k $\Omega$ ; 4-20mA: 500 $\Omega$
Factory Settings	Modbus Address 8AI1, 0-1mA: 136 8AI2, 0-20mA: 140 8AI3, 0-5V DC: 144 8AI4, 0-10V DC: 148
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20 csec

### 8.3: Normal Mode

- In Normal Mode, the Input Module:

1. Reads and averages the A/D and adjusts values for process 2.
2. Calculates the percentage of Input Value.

**NOTE:** The percentage value of the Input will be stored in Input Value registers (Registers 04097-04104)

- The device will operate with the following default parameters:

Address                    247 (F7H)  
Baud Rate                57600 Baud  
Transmit Delay Time    0

- Certain situations will cause the device to operate with the above default parameters. See Chapter 5 for details on Default Mode.

#### 8.3.1: Input Value, Channels 1-8

- Registers 04097-04104 (0x0000-0x01007).

Each register contains a 2-byte signed (two's complement) integer. The range is +327.67 %/ - 327.68 % and the unit is 0.01%. These registers contain the percentage of Input Value.

Example:

Register 04097 (0x01000), Input Value, Channel 1 might contain the following data:

Address (Hex)	04097(1000H)
Value (Hex)	183DH
2-byte Signed Integer	183DH
Most Significant Bit	0
2-byte Signed Integer (Decimal)	+6205
Percent	+62.05 %

Register 04097 (0x01000), Input Value, Channel 1 might contain the following data:

Address (Hex)	04097 (1000H)
Value (Hex)	E7C3H
2-byte Signed Integer (Hex)	E7C3H
Most Significant Bit	1
Compliment	183CH
Increment	183DH
2-byte Signed Integer (Decimal)	-6205
Percent	-62.05 %

### 8.3.2: Registers for Internal Calculation

The following registers are used by the I/O Module for internal calculation to calculate the percentage of the Input values. Therefore, these registers will not be explained in this manual.

Thermal Average A/D Value, Channels 1-8	Registers 04105-04112 (0x01008-0x0100F)
Thermal Average Reference	Register 04113 (0x01010)
A/D Count, Channels 1-8	Registers 04114-04121 (0x01011-0x01018)
A/D Count Reference	Registers 04122-04124 (0x01019-0x0101B)

### 8.3.3: Registers for Calibration

The following registers are used by the I/O Module for device calibration. This calibration is done in the factory, since it requires extremely high accuracy. Therefore, these registers will not be explained in this manual.

Calibrate Hi Percent, Channels 1-8	Registers 45073-45080 (0x0B010-0x0B017)
Calibrate Lo Percent, Channels 1-8	Registers 45081-45088 (0x0B018-0x0B01F)
Calibrate Hi Therm Avg A/D Value, Channels 1-8	Registers 45089-45096 (0x0B020-0x0B027)
Calibrate Lo Therm Avg A/D Value, Channels 1-8	Registers 45097-45104 (0x0B028-0x0B024)
Calibrate Mode	Register 57345 (0x0E000)



# Chapter 9

## Analog Input Modbus Register Map

### 9.1: Modbus Register Map

- The Analog Input Modbus Register Map begins on the page 9-3.

Maximum registers per request, read or write, is 17 registers.

- **Columns**

See Chapter 4 for a detailed description of Communication Formats referred to in the the Register Map's "Type" column. See the Table of Contents for a list of the Register Map's "Types" and their page location in Chapter 4.

The R/W column indicates the Read/Write function of that particular register. An R, W or R/W in the column indicates the following:

R	=	Read Only
W	=	Write Only
R/W	=	Read and Write





### Analog Input Modbus Map (8AI1, 8AI2, 8AI3, 8AI4)

Address	Description	Range	Units	Type	R/W	Notes
<b>Device Identification Block</b>						
00001-00008	Device Name			F1	R	
00009-00016	Firmware Variation String 1			F1	R	
00017-00024	Firmware Variation String 2			F1	R	
00025-00032	Firmware Variation String 3			F1	R	
00033-00040	Firmware Variation String 4			F1	R	
00041-00048	Firmware Variation String 5			F1	R	
00049-00056	Firmware Variation String 6			F1	R	
00057-00064	Firmware Variation String 7			F1	R	
00065-00072	Firmware Variation String 8			F1	R	
00073-00074	Device Firmware Version Number	9.9.9.9 / 0.0.0.0	0.0.0.1 version	F2	R	
00075-00076	Device Firmware Build Number	4,297,496,295 / 0	1 build	F3	R	
<b>Dynamic Data Block</b>						
04097	Input Value, Channel 1	+327.67%/-327.68%	0.01 %		R	
04098	Input Value, Channel 2	+327.67%/-327.68%	0.01 %		R	
04099	Input Value, Channel 3	+327.67%/-327.68%	0.01 %		R	
04100	Input Value, Channel 4	+327.67%/-327.68%	0.01 %		R	
04101	Input Value, Channel 5	+327.67%/-327.68%	0.01 %		R	
04102	Input Value, Channel 6	+327.67%/-327.68%	0.01 %		R	
04103	Input Value, Channel 7	+327.67%/-327.68%	0.01 %		R	
04104	Input Value, Channel 8	+327.67%/-327.68%	0.01 %		R	
04105	Thermal Average A/D Value, Channel 1	+4095.875 / -4096.000	1/8 count A/D		R	
04106	Thermal Average A/D Value, Channel 2	+4095.875 / -4096.000	1/8 count A/D		R	
04107	Thermal Average A/D Value, Channel 3	+4095.875 / -4096.000	1/8 count A/D		R	
04108	Thermal Average A/D Value, Channel 4	+4095.875 / -4096.000	1/8 count A/D		R	
04109	Thermal Average A/D Value, Channel 5	+4095.875 / -4096.000	1/8 count A/D		R	
04110	Thermal Average A/D Value, Channel 6	+4095.875 / -4096.000	1/8 count A/D		R	
04111	Thermal Average A/D Value, Channel 7	+4095.875 / -4096.000	1/8 count A/D		R	
04112	Thermal Average A/D Value, Channel 8	+4095.875 / -4096.000	1/8 count A/D		R	
04113	Thermal Average Reference	+4095.875 / -4096.000	1/8 count A/D		R	
04114	A/D Count, Channel 1	+4095/-4095	1 count A/D		R	
04115	A/D Count, Channel 2	+4095/-4095	1 count A/D		R	
04116	A/D Count, Channel 3	+4095/-4095	1 count A/D		R	
04117	A/D Count, Channel 4	+4095/-4095	1 count A/D		R	
04118	A/D Count, Channel 5	+4095/-4095	1 count A/D		R	
04119	A/D Count, Channel 6	+4095/-4095	1 count A/D		R	
04120	A/D Count, Channel 7	+4095/-4095	1 count A/D		R	
04121	A/D Count, Channel 8	+4095/-4095	1 count A/D		R	
04122	A/D Count Reference	+4095/-4095	1 count A/D		R	

### Analog Input Modbus Map (8AI1, 8AI2, 8AI3, 8AI4)

Address	Description	Range	Units	Type	R/W	Notes
04123	A/D Count Reference High	+4095/-4095	1 count A/D		R	
04124	A/D Count Reference Low	+4095/-4095	1 count A/D		R	
<b>Programmable Settings Block</b>						
45057	Address	1 - 247		F4	R/W	1
45058	Baud Rate			F5	R/W	1
45059	Transmit Delay Time	2.55 sec / 0.00 sec	0.01 sec	F6	R/W	1
45073	Calibrate Hi Percent, Channel 1	+327.67 % / - 327.68 %	0.01 %		R/W	1
45074	Calibrate Hi Percent, Channel 2	+327.67 % / - 327.68 %	0.01 %		R/W	1
45075	Calibrate Hi Percent, Channel 3	+327.67 % / - 327.68 %	0.01 %		R/W	1
45076	Calibrate Hi Percent, Channel 4	+327.67 % / - 327.68 %	0.01 %		R/W	1
45077	Calibrate Hi Percent, Channel 5	+327.67 % / - 327.68 %	0.01 %		R/W	1
45078	Calibrate Hi Percent, Channel 6	+327.67 % / - 327.68 %	0.01 %		R/W	1
45079	Calibrate Hi Percent, Channel 7	+327.67 % / - 327.68 %	0.01 %		R/W	1
45080	Calibrate Hi Percent, Channel 8	+327.67 % / - 327.68 %	0.01 %		R/W	1
45081	Calibrate Lo Percent, Channel 1	+327.67 % / - 327.68 %	0.01 %		R/W	1
45082	Calibrate Lo Percent, Channel 2	+327.67 % / - 327.68 %	0.01 %		R/W	1
45083	Calibrate Lo Percent, Channel 3	+327.67 % / - 327.68 %	0.01 %		R/W	1
45084	Calibrate Lo Percent, Channel 4	+327.67 % / - 327.68 %	0.01 %		R/W	1
45085	Calibrate Lo Percent, Channel 5	+327.67 % / - 327.68 %	0.01 %		R/W	1
45086	Calibrate Lo Percent, Channel 6	+327.67 % / - 327.68 %	0.01 %		R/W	1
45087	Calibrate Lo Percent, Channel 7	+327.67 % / - 327.68 %	0.01 %		R/W	1
45088	Calibrate Lo Percent, Channel 8	+327.67 % / - 327.68 %	0.01 %		R/W	1
45089	Calibrate Hi Thermal Average A/D Value, Channel 1	+4095.875 / -4096.000	1/8 count A/D		R	1
45090	Calibrate Hi Thermal Average A/D Value, Channel 2	+4095.875 / -4096.000	1/8 count A/D		R	1
45091	Calibrate Hi Thermal Average A/D Value, Channel 3	+4095.875 / -4096.000	1/8 count A/D		R	1
45092	Calibrate Hi Thermal Average A/D Value, Channel 4	+4095.875 / -4096.000	1/8 count A/D		R	1
45093	Calibrate Hi Thermal Average A/D Value, Channel 5	+4095.875 / -4096.000	1/8 count A/D		R	1
45094	Calibrate Hi Thermal Average A/D Value, Channel 6	+4095.875 / -4096.000	1/8 count A/D		R	1
45095	Calibrate Hi Thermal Average A/D Value, Channel 7	+4095.875 / -4096.000	1/8 count A/D		R	1
45096	Calibrate Hi Thermal Average A/D Value, Channel 8	+4095.875 / -4096.000	1/8 count A/D		R	1
45097	Calibrate Lo Thermal Average A/D Value, Channel 1	+4095.875 / -4096.000	1/8 count A/D		R	1
45098	Calibrate Lo Thermal Average A/D Value, Channel 2	+4095.875 / -4096.000	1/8 count A/D		R	1
45099	Calibrate Lo Thermal Average A/D Value, Channel 3	+4095.875 / -4096.000	1/8 count A/D		R	1
45100	Calibrate Lo Thermal Average A/D Value, Channel 4	+4095.875 / -4096.000	1/8 count A/D		R	1
45101	Calibrate Lo Thermal Average A/D Value, Channel 5	+4095.875 / -4096.000	1/8 count A/D		R	1
45102	Calibrate Lo Thermal Average A/D Value, Channel 6	+4095.875 / -4096.000	1/8 count A/D		R	1
45103	Calibrate Lo Thermal Average A/D Value, Channel 7	+4095.875 / -4096.000	1/8 count A/D		R	1
45104	Calibrate Lo Thermal Average A/D Value, Channel 8	+4095.875 / -4096.000	1/8 count A/D		R	1
<b>Action Block</b>						

### Analog Input Modbus Map (8AI1, 8AI2, 8AI3, 8AI4)

Address	Description	Range	Units	Type	R/W	Notes
57345	Calibration Mode				W	
<b>Device Status Block</b>						
65409	Device Status			F7	R	
65410	Device Reset			F8	W	
65535-65536	Device Serial Number	99999999 / 0	1	F9	R	

# Chapter 10

## Relay Output Modules

### 10.1: Overview

- The Relay Output Module consists of four Latching Relay Outputs. In Normal Mode, the device accepts commands to control the relays.
- The Modbus Map for the Relay Output I/O Module (4RO1) is in Chapter 11.

### 10.2: Relay Output Specifications

RELAY OUTPUT MODULE SPECIFICATIONS	
Model Numbers	4RO1: 4 Latching Relay Outputs
Accuracy	0.1% of Full Scale
Scaling	Programmable
Communication	RS-485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 57600
Power Requirement	15-20V DC at 50-200mA
Operating Temperature	-20°C to 79°C / -4°F to +158°F
Maximum Load Impedance	0-1mA: 10k Ω; 4-20mA: 500 Ω
Factory Settings	Modbus Address: 156
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20 csec

### 10.3: Communication

- Maximum registers per request, read or write, is 4 registers.
- The device will operate with the following default parameters:
 

Address	247 (F7H)
Baud Rate	57600 Baud
Transmit Delay Time	20 csec
- Some situations will cause the device to operate with the above default parameters. See Chapter 5 for details of Default Mode.

## 10.4: Normal Mode

- Normal Mode consists of one process:

1. The device accepts new commands to control the relays.

### 10.4.1: Relay State

- Register 04097 (0x01000)

The following bits indicate each relay:

Bit 0:	Relay 1
Bit 1:	Relay 2
Bit 2:	Relay 3
Bit 3:	Relay 4

A bit value of 0 indicates contact between Common and NC (Normal Close).

A bit value of 1 indicates contact between Common and NO (Normal Open).

This Relay State will be stored in EEPROM whenever there is a change in the value.

### 10.4.2: Relay Select, Relay Command

- Register 04098 (0x01001) and Register 04099 (0x01002)

The relays can be controlled in two steps:

1. Write to the Relay Select Register 04098 (0x01001)
2. Write to the Relay Command Register 04099 (0x01002)

First, select the relay to control. Write the following values to control the relays:

- 0 (0x0000) for Relay 1
- 1 (0x0001) for Relay 2
- 2 (0x0002) for Relay 3
- 3 (0x0003) for Relay 4

Second, choose the command to control the relay.

Write the following values to choose the commands:

- 0 (0x0000) for Latch Off Command
- 1 (0x0001) for Latch On Command
- 2 (0x0002) for Pulse Off Command
- 3 (0x0003) for Pulse On Command

### 10.4.3: Relay On/Off Timers

#### ■ Registers 04100-04107 (0x01003 - 0x01003)

The value in these registers will start to decrement upon receiving Pulse On/Off Commands. The unit of value in these registers is 0.01 second. The proper On/Off Timer values should be written before using Pulse On/Off Commands.

### 10.4.4: Latch On/Off Commands

Upon receiving a Latch On Command, the device will make contact between NO (Normal Open) and Common for the relay selected.

Upon receiving a Latch Off Command, the device will make contact between NC (Normal Close) and Common for the relay selected.

### 10.4.5: Pulse On/Off Commands

These commands will work with the values in Relay On/Off Timer registers.

Upon receiving a Pulse On Command, the device will make contact between NO (Normal Open) and Common for the time in Relay On Timer and make contact between NC (Normal Close) and Common for the time in Relay Off Timer. Then, the relay will stay at NC (Normal Close). The values in Relay On/Off Time Registers will become zeros. For another Pulse Command, the Timer On/Off values should be given to the device again.

Upon receiving a Pulse Off Command, the device will make contact between NC (Normal Close) and Common for the time in Relay Off Timer and make contact between NO (Normal Open) and Common for the time in Relay On Timer. Then the relay will stay at NO (Normal Open). The values in Relay On/Off Time Registers will become zeros. For another Pulse Command, the Timer On/Off values should be given to the device again.

For example, in order to have Relay 1 do a 4-second Pulse On, do the following steps:

1. Write 4000 to Register 04101 (0x01004) for Relay On Timer.
2. Write 0 to Register 04098 (0x01001) to select Relay 1.
3. Write 3 to Register 04099 (0x01002) to send Pulse On Command.

Upon receiving this command, the device will make contact between NO (Normal Open) and Common for 4 seconds and make contact between NC (Normal Close) and Common.





# Chapter 11

## Relay Output Modbus Register Map

### 11.1: Relay Output Modbus Register Map

- The Relay Output Modbus Register Map begins on page 11-3.

Maximum registers per request, read or write, is 4 registers.

- **Columns**

See Chapter 4 for a detailed description of Communication Formats referred to in the the Register Map's "Type" column. See the Table of Contents for a list of the Register Map's "Types" and their page location in Chapter 4.

The R/W column indicates the Read/Write function of that particular register. An R, W or R/W in the column indicates the following:

R	=	Read Only
W	=	Write Only
R/W	=	Read and Write



## Digital Relay Output Modbus Map (4RO1)

Address	Description	Range	Units	Type	R/W	Notes
<b>Device Identification Block</b>						
00001-00008	Device Name			F1	R	
00009-00016	Firmware Variation String 1			F1	R	
00017-00024	Firmware Variation String 2			F1	R	
00025-00032	Firmware Variation String 3			F1	R	
00033-00040	Firmware Variation String 4			F1	R	
00041-00048	Firmware Variation String 5			F1	R	
00049-00056	Firmware Variation String 6			F1	R	
00057-00064	Firmware Variation String 7			F1	R	
00065-00072	Firmware Variation String 8			F1	R	
00073-00074	Device Firmware Version Number	9.9.9.9 / 0.0.0.0	0.0.0.1 version	F2	R	
00075-00076	Device Firmware Build Number	4,297,496,295 / 0	1 build	F3	R	
00077	Device Option			F10	R	
<b>Dynamic Data Block</b>						
04097	Relay State				R	
04098	Relay Select				R/W	
04099	Relay Command				R/W	
04100	Relay 1 Off Timer	65535/0	0.01 sec		R/W	
04101	Relay 1 On Timer	65535/0	0.01 sec		R/W	
04102	Relay 2 Off Timer	65535/0	0.01 sec		R/W	
04103	Relay 2 On Timer	65535/0	0.01 sec		R/W	
04104	Relay 3 Off Timer	65535/0	0.01 sec		R/W	
04105	Relay 3 On Timer	65535/0	0.01 sec		R/W	
04106	Relay 4 Off Timer	65535/0	0.01 sec		R/W	
04107	Relay 4 On Timer	65535/0	0.01 sec		R/W	
<b>Programmable Settings Block</b>						
45057	Address	1 - 247		F4	R/W	
45058	Baud Rate			F5	R/W	
45059	Transmit Delay Time	2.55 sec / 0.00 sec	0.01 sec	F6	R/W	
<b>Device Status Block</b>						
65409	Device Status			F7	R	
65410	Device Reset			F8	W	
65535-65536	Device Serial Number	99999999 / 0	1	F9	R	

# Chapter 12

## KYZ Pulse Output Modules

### 12.1: Overview

- The KYZ Pulse Output Modules have 4 KYZ Pulse Outputs and accept Read and Write Commands with at least 4 registers of data per command.
- The Modbus Map for the KYZ Pulse Output Modules is in Chapter 13.
- Maximum registers per request, read or write, is 4 registers.

### 12.2: KYZ Pulse Output Specifications

KYZ PULSE OUTPUT MODULE SPECIFICATIONS	
Model Numbers	4PO1
Communication	RS-485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 57600
Power Requirement	15-20V DC at 50-200mA
Operating Temperature	-20°C to 79°C / -4°F to +158°F
Voltage Rating	Up to 300V DC
Commands Accepted	Read and Write with at least 4 registers of data per command
Memory	256 byte I <sup>2</sup> C EEPROM for storage of Programmable Settings and Nonvolatile Memory.
Factory Settings	Modbus Address: 160
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 247
	Baud Rate: 57600
	Transmit Delay Time: 20 csec

**NOTE:** See Appendix A - Glossary for Modbus Map terms.

### 12.3: Communication

- Maximum registers per request, read or write, is 4 registers.
- The device will operate with the following default parameters:

Address	247 (F7H)
Baud Rate	57600 Baud
Transmit Delay Time	20 csec

- Certain situations will cause the device to operate with the above default parameters. See Chapter 5 for details of Default Mode.

### 12.4: Normal Mode

- Energy readings are given to the device frequently. The device generates a pulse at each channel after a certain energy increase.
- Normal Operation consists of three processes:
  1. The first process accepts writes to registers 04097 - 04112. Writes can be up to four registers long and should end on the fourth register of a group (register 04100, or registers 04103-04112 or registers 04109-04112). These writes can be interpreted as two-byte, four-byte, six-byte or eight-byte energy readings. The reception of the first value for a given channel provides the initial value for that channel. Subsequent writes will increment the Residual for that channel by the difference of the old value and the new value. The previous value is then replaced with the new value.

Attempting to write a value greater than the programmed Rollover Value for a given channel is completely ignored and no registers are modified. If the difference is greater than half of the programmed Rollover Value for a given channel, the write does not increment the Residual but does update the Last Value. Overflow of the Residual is not prevented.

2. The second process occurs in the main loop and attempts to decrement the Residual by the Programmed Energy/Pulse Value. If the Residual is greater than the Programmed Energy/Pulse Value and the Pending Pulses Value for that channel is not maxed, then Residual is decremented appropriately and the Pending Pulses is incremented by two, signifying two more transitions and one more pulse.
3. The third process runs from a timer which counts off pulse widths from the Programmable Minimum Pulse Width Values. If there are Pulses Pending for a channel and the delay has passed, then the Pulses Pending is decremented for that channel and the Output Relay is toggled.

■ Operation Indicator (0000H = OK, 1000H = Problem)

- Bit 1: 1 = EEPROM Failure
- Bit 2: 1 = Checksum for Communications Settings bad
- Bit 3: 1 = Checksum for Programmable Settings bad
- Bit 4: 1 = 1 or more Communications Settings are invalid
- Bit 5: 1 = 1 or more Programmable Settings are invalid
- Bit 6: 1 = 1 or more Programmable Settings have been modified
- Bit 7: 1 = Forced Default by Reset Switch
  
- Bit 15: 1 = Normal Operation of the device is disabled

#### 12.4.1: Channel Last/Next Energy, Channels 1-4

■ Registers 04097-04112 (0x01000-0x01000F)

Energy readings are written to these registers. The reading is an 8-byte value. The range is 18,446,744,073,709,551,615 / 0.

The Master Device continuously writes energy readings to these registers. New readings will overwrite the old readings. The difference between old readings and new readings will be added to the Channel Residual Energy registers.

#### 12.4.2: Channel Residual Energy, Channels 1-4

■ Registers 04113-04128 (0x01010-0x0101F)

When the new energy readings are different from the old readings, the difference will be added to these registers. The reading is also an 8-byte value. The range is 18,446,744,073,709,551,615 / 0. If the number in these registers is larger than or equal to the number in the Channel Energy/Pulse registers, the number in the Channel Residual Energy registers will decrease by the number in the Channel Energy/Pulse registers until the number in the Channel Residual Energy registers becomes smaller than the number in the Channel Energy/Pulse registers. When the number in the Channel Residual Energy registers decreases, the number in the Channel Pending Pulse registers will increment.

#### 12.4.3: Channel Pending Pulse, Channels 1-4

■ Registers 04129-04132 (0x01020-0x01023)

These registers update the number of pulses to be sent out to each channel. The reading is a 2-byte value and the range is 65535 / 0.

The number will decrement when a pulse is generated at the output.

#### 12.4.4: Channel Energy/Pulse, Channels 1-4

■ Registers 45073-45080 (0x0B010-0x0B017)

These registers contain the energy readings per pulse. The reading is a 4-byte value and the range is

4,294,967,296 / 0.

#### 12.4.5: Channel Rollover, Channels 1-4

■ Registers 45081-45096 (0x0B018-0x0B027)

These registers contain the Energy Rollover Readings for each channel. The reading is an 8-byte value and the range is 18,446,744,073,709,551,615 / 0. These rollover values should be from the Master Device.

For example, the Master Device has a Rollover Energy Reading of 100,000. This value should be written in this register. When the Energy Reading changes from 99,992 to 1 in the Channel Last/Next Energy register, a value of 9 is added to the Residual Energy Reading and a Rollover occurs.

#### 12.4.6: Channel Minimum Pulse Width, Channels 1-4

■ Registers 45097-45100 (0x0B028-0x0B02B)

These registers contain the minimum time between transitions. The reading is a 2-byte value and the unit is a centisecond. The range is 0 - 2.55 seconds.

For example, the register has a value of 10. This means that the Output will have a contact between NO (Normal Open) and Common for 10 centiseconds (0.1 second) and will have a contact between NC (Normal Close) and Common for 10 centiseconds.

#### 12.4.7: Reset Channels

■ Registers 57345-57349 (0x0E000-0x0E004)

Reset All Channels (57345):	Clears all the Last Energy, Residual Energy and Pending Pulses when written.
Reset Channels 1 - 4 (57346-57349):	Clears the Last Energy, Residual Energy and Pending Pulses of the appropriate channel when written.
Device Reset (65410):	Asks the device to reset, reinitializing Programmable Settings from the FC EEPROM.

While operating, if the Reset Switch is pressed for at least 2 seconds, the system resets. If the Reset Switch is pressed during power up, the unit will go into Default Mode as described in Chapter 5.

**NOTE:** Programmable Settings are stored in a block in the FC EEPROM with a checksum at the end of the block. Any write to the Programmable Settings modifies the settings, recomputes and rewrites the checksum on the block. Changes to these settings do not go into operational effect until the system resets.

# Chapter 13

## KYZ Pulse Outputs Modbus Register Map

- The Nexus Modbus Register Map begins on page 13-3.

- **Columns**

See Chapter 4 for a detailed description of Communication Formats referred to in the the Register Map's "Type" column. See the Table of Contents for a list of the Register Map's "Types" and their page location in Chapter 4.

The R/W column indicates the Read/Write function of that particular register. An R, W or R/W in the column indicates the following:

R	=	Read Only
W	=	Write Only
R/W	=	Read and Write





## KEYZ Pulse Outputs Modbus Map

Address	Description	Range	Units	Type	R/W	Notes
<b>Device Identification Block</b>						
00001-00008	Device Name			F1	R	
00009-00016	Firmware Variation String 1			F1	R	
00017-00024	Firmware Variation String 2			F1	R	
00025-00032	Firmware Variation String 3			F1	R	
00033-00040	Firmware Variation String 4			F1	R	
00041-00048	Firmware Variation String 5			F1	R	
00049-00056	Firmware Variation String 6			F1	R	
00057-00064	Firmware Variation String 7			F1	R	
00065-00072	Firmware Variation String 8			F1	R	
00073-00074	Device Firmware Version Number	9.9.9.9 / 0.0.0.0	0.0.0.1 version	F2	R	
00075-00076	Device Firmware Build Number	4,297,496,295 / 0	1 build	F3	R	
<b>Dynamic Data Block</b>						
04097-04100	Channel 1 Last/Next Energy	18,446,744,073,709,551,615 / 0			R/W	
04101-04104	Channel 2 Last/Next Energy	18,446,744,073,709,551,615 / 0			R/W	
04105-04108	Channel 3 Last/Next Energy	18,446,744,073,709,551,615 / 0			R/W	
04109-04112	Channel 4 Last/Next Energy	18,446,744,073,709,551,615 / 0			R/W	
04113-04116	Channel 1 Residual Energy	18,446,744,073,709,551,615 / 0			R	
04117-04120	Channel 2 Residual Energy	18,446,744,073,709,551,615 / 0			R	
04121-04124	Channel 3 Residual Energy	18,446,744,073,709,551,615 / 0			R	
04125-04128	Channel 4 Residual Energy	18,446,744,073,709,551,615 / 0			R	
04129	Channel 1 Pending Pulses				R	
04130	Channel 2 Pending Pulses				R	
04131	Channel 3 Pending Pulses				R	
04132	Channel 4 Pending Pulses				R	
<b>Programmable Settings Block</b>						
45057	Address	1 - 247		F4	R/W	1
45058	Baud Rate			F5	R/W	1
45059	Receive > Transmit Delay	2.55 sec / 0.00 sec	0.01 sec	F6	R/W	1
45073-45074	Channel 1 Energy/Pulse	4,294,967,296 / 0			R/W	
45075-45076	Channel 2 Energy/Pulse	4,294,967,296 / 0			R/W	
45077-45078	Channel 3 Energy/Pulse	4,294,967,296 / 0			R/W	
45079-45080	Channel 4 Energy/Pulse	4,294,967,296 / 0			R/W	
45081-45084	Channel 1 Rollover	18,446,744,073,709,551,615 / 0			R/W	
45085-45088	Channel 2 Rollover	18,446,744,073,709,551,615 / 0			R/W	
45089-45092	Channel 3 Rollover	18,446,744,073,709,551,615 / 0			R/W	
45093-45096	Channel 4 Rollover	18,446,744,073,709,551,615 / 0			R/W	
45097	Channel 1 Minimum Pulse Width				R/W	
45098	Channel 2 Minimum Pulse Width				R/W	

## KYZ Pulse Outputs Modbus Map

Address	Description	Range	Units	Type	R/W	Notes
45099	Channel 3 Minimum Pulse Width				R/W	
45100	Channel 4 Minimum Pulse Width				R/W	
<b>Action Block</b>						
57345	Reset All Channels				W	
57346	Reset Channel 1				W	
57347	Reset Channel 2				W	
57348	Reset Channel 3				W	
57349	Reset Channel 4				W	
<b>Device Status Block</b>						
65409	Device Status			F7	R	
65410	Device Reset			F8	W	
65535-65536	Device Serial Number	99999999 / 0	1	F9	R	

# Chapter 14

## Digital Status Input Modules

### 14.1: Overview

- The Digital Status Input Module is used for either additional status detect or for accumulating pulses from external equipment, such as power meters, water meters, etc.
- The Modbus Map for the Digital Status Input Module is in Chapter 15.
- Maximum registers per request, read or write, is 4 registers.

### 14.2: Digital Status Input Specifications

DIGITAL STATUS INPUT MODULE SPECIFICATIONS	
Model Numbers	8DI1
Communication	RS-485, Modbus RTU
	Programmable Baud Rates: 4800, 9600, 19200, 57600
Power Requirement	15-20V DC at 50-200mA
Operating Temperature	-20°C to 79°C / -4°F to +158°F
Voltage Rating	Up to 300V DC
Detection	Wet, Dry, Auto Detect
Memory	256 byte I <sup>2</sup> C EEPROM for storage of Programmable Settings and Nonvolatile Memory
Factory Settings	Modbus Address: 164
	Baud Rate: 57600
	Transmit Delay Time: 0
Default Settings (Reset Button)	Modbus Address: 5247
	Baud Rate: 57600
	Transmit Delay Time: 20 csec

### 14.3: Communication

- The device will operate with the following default parameters:
  - Address                    247 (F7H)
  - Baud Rate                57600 Baud
  - Transmit Delay Time    20 csec
- See Chapter 5 for details on Default Mode.

## 14.4: Normal Mode

- The device is polling the inputs at 100 Hz (once every 10 msec), debouncing the inputs and incrementing the Transition Accumulators for each channel as appropriate.

The inputs are represented by Channel 1 in the LSB through Channel 8 in the MSB of the low order byte of the register.

### 14.4.1: Input States

- Register 04097 (0x01000)
- Input States is a 16-bit reading. Each bit is either a 1 or a 0.
- Inputs are assigned to the bits in the following way:
  - Bit 0: Channel 1
  - Bit 1: Channel 2
  - Bit 2: Channel 3
  - Bit 3: Channel 4
  - Bit 4: Channel 5
  - Bit 5: Channel 6
  - Bit 6: Channel 7
  - Bit 7: Channel 8
  - Bit 8-15: Not used.

A bit value of 1 indicates that the input is open; a bit value of 0 indicates that the input is closed. Input states are debounced at a rate of 100 Hz, which means that minimum pulse widths should be about 2 centiseconds wide.

For example,

1. If the input changes like the following at the sample rate, this is not regarded as a transition:
  - open-close-open (no transition)
  - close-open-close (no transition)
2. If the input changes like the following, this is regarded as one transition:
  - open-close-close-open (transition from open to close)
  - close-open-open-close (transition from close to open)

### 14.4.2: Channel Transitions

- Registers 04098-04113 (0x01001-0x01001)
- Transition Registers are accumulators that count the number of transitions an input makes. These values are stored in EEPROM every two minutes whenever there is a change in the number.

### 14.4.3: Channel Rollover, Channels 1-8

- Registers 45073-45088 (0x0B010-0x0B01F)
- Rollover Registers keep the largest value for each channel that Transition Accumulators can obtain. A rollover will occur according to the value written into the Rollover Settings. Rollover Settings are cleared by communication commands to the Programmable Settings Block. Settings are stored to the EEPROM when cleared. When they have incremented, settings are stored after two minutes have passed since the last time they were stored. Settings are retrieved from the EEPROM on Powerup.

Programmable Settings are stored in a block in the FC EEPROM with a checksum at the end of the block. Any write to the Programmable Settings modifies the setting and recomputes and rewrites the checksum to the block. Changes to these settings do not go into operational effect until the unit resets and reinitializes. Device Reset asks the device to reset, reinitializing Programmable Settings from the FC EEPROM.

### 14.4.4: Reset Channel Transition Accumulations, Channels 1-8

- Registers 57345-57353 (0x0E000-0x0E008)

Writing any value to these registers will cause the following reset of Channel Transition Accumulations:

Reset All Transition Accum (57345)	Reset All Channel Transition Accumulations.
Reset Channel Accum, Channels 1-8	Reset Individual Channels Transition Accumulations



# Chapter 15

## Digital Status Input Modbus Register Map

- The Modbus Register Map for the Digital Status Input I/O Module (8DI1) begins on the page 15-3.

- **Columns**

See Chapter 4 for a detailed description of Communication Formats referred to in the the Register Map's "Type" column. See the Table of Contents for a list of the Register Map's "Types" and their page location in Chapter 4.

The R/W column indicates the Read/Write function of that particular register. An R, W or R/W in the column indicates the following:

R	=	Read Only
W	=	Write Only
R/W	=	Read and Write





## Digital Input Modbus Map (8DI1)

Address	Description	Range	Units	Type	R/W	Notes
<b>Device Identification Block</b>						
00001-00008	Device Name			F1	R	
00009-00016	Firmware Variation String 1			F1	R	
00017-00024	Firmware Variation String 2			F1	R	
00025-00032	Firmware Variation String 3			F1	R	
00033-00040	Firmware Variation String 4			F1	R	
00041-00048	Firmware Variation String 5			F1	R	
00049-00056	Firmware Variation String 6			F1	R	
00057-00064	Firmware Variation String 7			F1	R	
00065-00072	Firmware Variation String 8			F1	R	
00073-00074	Device Firmware Version Number	9.9.9.9 / 0.0.0.0	0.0.0.1 version	F2	R	
00075-00076	Device Firmware Build Number	4,297,496,295 / 0	1 build	F3	R	
<b>Dynamic Data Block</b>						
04097	Input States				R	
04098-04099	Channel 1 Transitions	4,294,967,295 / 0			R	
04100-04101	Channel 2 Transitions	4,294,967,295 / 0			R	
04102-04103	Channel 3 Transitions	4,294,967,295 / 0			R	
04104-04105	Channel 4 Transitions	4,294,967,295 / 0			R	
04106-04107	Channel 5 Transitions	4,294,967,295 / 0			R	
04108-04109	Channel 6 Transitions	4,294,967,295 / 0			R	
04110-04111	Channel 7 Transitions	4,294,967,295 / 0			R	
04112-04113	Channel 8 Transitions	4,294,967,295 / 0			R	
<b>Programmable Settings Block</b>						
45057	Address	1 - 247		F4	R/W	1
45058	Baud Rate			F5	R/W	1
45059	Receive > Transmit Delay	2.55 sec / 0.00 sec	0.01 sec	F6	R/W	1
45073-45074	Channel 1 Rollover	4,294,967,295 / 0			R/W	
45075-45076	Channel 2 Rollover	4,294,967,295 / 0			R/W	
45077-45078	Channel 3 Rollover	4,294,967,295 / 0			R/W	
45079-45080	Channel 4 Rollover	4,294,967,295 / 0			R/W	
45081-45082	Channel 5 Rollover	4,294,967,295 / 0			R/W	
45083-45084	Channel 6 Rollover	4,294,967,295 / 0			R/W	
45085-45086	Channel 7 Rollover	4,294,967,295 / 0			R/W	
45087-45088	Channel 8 Rollover	4,294,967,295 / 0			R/W	
<b>Action Block</b>						
57345	Reset All Transition Accumulations				W	
57346	Reset Channel 1 Transition Accumulation	4,294,967,295 / 0			W	
57347	Reset Channel 2 Transition Accumulation	4,294,967,295 / 0			W	
57348	Reset Channel 3 Transition Accumulation	4,294,967,295 / 0			W	

## Digital Input Modbus Map (8DI1)

Address	Description	Range	Units	Type	R/W	Notes
57349	Reset Channel 4 Transition Accumulation	4,294,927,295 / 0			W	
57350	Reset Channel 5 Transition Accumulation	4,294,927,295 / 0			W	
57351	Reset Channel 6 Transition Accumulation	4,294,927,295 / 0			W	
57352	Reset Channel 7 Transition Accumulation	4,294,927,295 / 0			W	
57353	Reset Channel 8 Transition Accumulation	4,294,927,295 / 0			W	
<b>Device Status Block</b>						
65409	Device Status			F7	R	
65410	Device Reset			F8	W	
65535-65536	Device Serial Number	99999999 / 0	1	F9	R	

# Appendix A

## Glossary

Address:	The Device Address used for Modbus Communication. Valid values are between 1 and 247, inclusive.
Average (Current):	When applied to current values (amps) the average is a calculated value that corresponds to the thermal average over a specified time interval. The interval is specified by the user in the meter profile. The interval is typically 15 minutes. So, Average Amps is the thermal average of amps over the previous 15-minute interval. The thermal average rises to 90% of the actual value in each time interval. For example, if a constant 100 amp load is applied, the thermal average will indicate 90 amps after one time interval, 99 amps after two time intervals and 99.9 amps after three time intervals.
Average (Input Pulse Accumulations):	When applied to Input Pulse Accumulations, the “Average” refers to the block (fixed) window average value of the input pulses.
Average (Power):	When applied to power values (watts, VARs, VA), the average is a calculated value that corresponds to the thermal average over a specified time interval. The interval is specified by the user in the meter profile. The interval is typically 15 minutes. So, the Average Watts is the thermal average of watts over the previous 15-minute interval. The thermal average rises to 90% of the actual value in each time interval. For example, if a constant 100kW load is applied, the thermal average will indicate 90kW after one time interval, 99kW after two time intervals and 99.9kW after three time intervals.
Bit:	A unit of computer information equivalent to the result of a choice between two alternatives (Yes/No, On/Off, for example). Or, the physical representation of a bit by an electrical pulse whose presence or absence indicates data.
Binary:	Relating to a system of numbers having 2 as its base (digits 0 and 1).
Block Window Avg: (Power)	The Block (Fixed) Window Average is the average power calculated over a user-set time interval, typically 15 minutes. This calculated average corresponds to the demand calculations performed by most electric utilities in monitoring user power demand. (See Rolling Window Average.)
Build Number:	Incremented at least for every internal release and used for internal testing.
Byte:	A group of 8 binary digits processed as a unit by a computer (or device) and used especially to represent an alphanumeric character.

Channel:	The storage of a single value in each interval in a load profile.
CRC Field:	Cyclic Redundancy Check Field (Modbus communication) is an error checksum calculation that enables a Slave device to determine if a request packet from a Master device has been corrupted during transmission. If the calculated value does not match the value in the request packet, the Slave ignores the request.
Demand:	The average value of power or a similar quantity over a specified period of time.
Demand Interval:	A specified time over which demand is calculated.
Device Name:	Unique per device name starting with the four digit numeric identification for the firmware (EIF Number).
Device Reset:	Asks the device to reset, reinitializing Programmable Settings from the I <sup>2</sup> C EEPROM.
Display:	User-configurable visual indication of data in a meter.
DNP 3.0:	A robust, non-proprietary protocol based on existing open standards. DNP 3.0 is used to operate between various systems in electric and other utility industries and SCADA networks.
EEPROM:	Nonvolatile memory. Electrically Erasable Programmable Read Only Memory that retains its data during a power outage without need for a battery. Also refers to meter's FLASH memory.
Energy/Pulse:	The amount of Primary Energy required to produce a pulse (pair of transitions).
Energy Register:	Programmable record that monitors any energy quantity. Example: Watthours, VARhours, VAhours.
Ethernet:	A type of LAN network connection that connects two or more devices on a common communications backbone. An Ethernet LAN consists of at least one hub device (the network backbone) with multiple devices connected to it in a star configuration. The most common versions of Ethernet in use are 10BaseT or 100BaseT as defined in IEE standards. However, several other versions of Ethernet are also available.
Exception Response:	Error Code (Modbus communication) transmitted in a packet from the Slave to the Master if the Slave has encountered an invalid command or other problem.
Form:	Wiring and Hookup configuration for the Nexus 1262/1272.
Harmonics:	Measuring values of the fundamental current and voltage and percent of the fundamental.

Heartbeat Pulse:	Energy indicator on the face of the Nexus 1252; pulses are generated per the programmed $K_e$ value.
Infrared Test Pulse:	Energy indicator located on the upper left side of the face of the Nexus 1262 /1272 meter; pulses are generated per the programmed $K_e$ value.
Integer:	Any of the natural numbers, the negatives of those numbers or zero.
Internal Modem:	An optional modem within the meter's enclosure that connects to the RJ-11 telephone connector.
Invalid Register:	In the Nexus Modbus Map there are gaps between Registers. For example, the next Register after 08320 is 34817. Any unmapped Register stores no information and is said to be invalid.
ITIC Curve:	An updated version of the CBEMA Curve that reflects further study into the performance of microprocessor devices. The curve consists of a series of steps but still defines combinations of voltage magnitude and duration that will cause malfunction or damage.
$K_e$ :	kWh per pulse; i.e. the energy.
kWh:	kilowatt hours; kW x demand interval in hours.
KYZ Output:	Output where the rate of changes between 1 and 0 reflects the magnitude of a metered quantity.
Last/Next Energy:	Register written to with the next energy reading for a channel. The register can be read from to see the last energy reading written.
LCD:	Liquid Crystal Display.
LED:	Light Emitting Diode.
Master Device:	In Modbus communication, a Master Device initiates and controls all information transfer in the form of a Request Packet to a Slave Device. The Slave responds to each request.
Maximum Demand:	The largest demand calculated during any interval over a billing period.
Minimum Pulse Width	Minimum time between transitions, which is measured in centiseconds (0-2.55 sec).
Modbus ASCII:	Alternate version of the Modbus protocol that utilizes a different data transfer format. This version is not dependent upon strict timing, as is the RTU version. This is the best choice for telecommunications applications (via modems).

Modbus RTU:	The most common form of Modbus protocol. Modbus RTU is an open protocol spoken by many field devices to enable devices from multiple vendors to communicate in a common language. Data is transmitted in a timed binary format, providing increased throughput and therefore, increased performance.
Network:	A communications connection between two or more devices to enable those devices to send and receive data to one another. In most applications, the network will be either a serial type or a LAN type.
NVRAM:	Non-volatile Random Access Memory is able to keep the stored values in memory even during the loss of circuit or control power. High speed NVRAM is used in the Nexus to gather measured information and to insure that no information is lost.
Optical Port:	A port that facilitates infrared communication with a (1262/1272) meter. Using an ANSI C12.13 Type II magnetic optical communications coupler and an RS-232 cable from the coupler to a PC, the meter can be programmed with Nexus Communicator software.
Packet:	A short fixed-length section of data that is transmitted as a unit. Example: a serial string of 8-bit bytes.
Percent (%) THD:	Percent Total Harmonic Distortion.
Protocol:	A language that will be spoken between two or more devices connected on a network.
PT Ratio:	Potential Transformer Ratio used to scale the value of the voltage to the primary side of an instrument transformer. Also referred to as VT Ratio.
Pulse:	The closing and opening of the circuit of a two-wire pulse system or the alternate closing and opening of one side and then the other of a three-wire system (which is equal to two pulses).
Pulses Pending:	The number of transitions waiting to be output by relays.
Quadrant: (Programmable Values and Factors on the Nexus)	Watt and VAR flow is typically represented using an X-Y coordinate system. The four corners of the X-Y plane are referred to as quadrants. Most power applications label the right hand corner as the first quadrant and number the remaining quadrants in a counter-clockwise rotation. Following are the positions of the quadrants: 1st - upper right, 2nd - upper left, 3rd - lower left and 4th - lower right. Power flow is generally positive in quadrants 1 and 4. VAR flow is positive in quadrants 1 and 2. The most common load conditions are: Quadrant 1 - power flow positive, VAR flow positive, inductive load, lagging or positive power factor; Quadrant 2 - power flow negative, VAR flow positive, capacitive load, leading or negative power factor.

Receive > Transmit Delay	The minimum time between receiving a request and transmitting a response, measured in 100 microseconds (0-25.5 msec).
Register:	An entry or record that stores a small amount of data.
Register Rollover:	A point at which a Register reaches its maximum value and rolls over to zero.
Reset:	Logs are cleared or new (or default) values are sent to counters or timers.
Residual Energy:	Accumulated energy not yet allocated as pulses.
Rolling Window Average (Power):	The Rolling (Sliding) Window Average is the average power calculated over a user-set time interval that is derived from a specified number of sub-intervals, each of a specified time. For example, the average is calculated over a 15-minute interval by calculating the sum of the average of three consecutive 5-minute intervals. This demand calculation methodology has been adopted by several utilities to prevent customer manipulation of kW demand by simply spreading peak demand across two intervals.
Rollover:	The largest value that Transition Accumulators for a channel can obtain.
RS-232:	A type of serial network connection that connects two devices to enable communication between devices. An RS-232 connection connects only two points. Distance between devices is typically limited to fairly short runs. Current standards recommend a maximum of 50 feet but some users have had success with runs up to 100 feet. Communications speed is typically in the range of 1200 bits per second to 57,600 bits per second. RS-232 communication can be accomplished using the Optical port on the face of the 1262/1272 Nexus.
RS-485:	A type of serial network connection that connects two or more devices to enable communication between the devices. An RS-485 connection will allow multi-drop communication from one to many points. Distance between devices is typically limited to around 2,000 to 3,000 wire feet. Communications speed is typically in the range of 120 bits per second to 115,000 bits per second.
Sag:	A voltage quality event during which the RMS voltage is lower than normal for a period of time, typically from 1/2 cycle to 1 minute.
Secondary Rated:	Any Register or pulse output that does not use any CT or VT Ratio.
Serial Port:	The type of port used to directly interface with a PC.
Slave Device:	In Modbus communication, a Slave Device only receives a Request Packet from a Master Device and responds to the request. A Slave Device cannot initiate communication.
Swell:	A voltage quality event during which the RMS voltage is higher than normal for a period of time, typically from 1/2 cycle to 1 minute.



THD:	Total Harmonic Distortion is the combined effect of all harmonics measured in a voltage or current. The THD number is expressed as a percent of the fundamental. For example, a 3% THD indicates that the magnitude of all harmonic distortion measured equals 3% of the magnitude of the fundamental 60Hz quantity.
Time Stamp:	A stored representation of the time of an event. Time Stamp can include year, month, day, hour, minute and second and Daylight Savings Time indication.
TOU:	Time of Use.
Variation Strings:	Identification for different variations of a device based on compile-time switches.
Version Number:	Incremented with the first build after an official release.
Voltage Imbalance:	The ratio of the voltage on a phase to the average voltage on all phases.
Voltage Quality Event:	An instance of abnormal voltage on a phase. The events the meter will track include sags, swells, interruptions and imbalances.
VT Ratio:	The Voltage Transformer Ratio is used to scale the value of the voltage to the primary side of an instrument transformer. Also referred to as PT Ratio.
Voltage, Vab:	Vab, Vbc, Vca are all Phase-to-Phase voltage measurements. These voltages are measured between the three phase voltage inputs to the meter.
Voltage, Van:	Van, Vbn, Vcn are all Phase-to-Neutral voltages applied to the monitor. These voltages are measured between the phase voltage inputs and Vn input to the meter. Technologically, these voltages can be “measured” even when the meter is in a Delta configuration and there is no connection to the Vn input. However, in this configuration, these voltages have limited meaning and are typically not reported.